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TECHNICAL PAPER
RAC-TP-189

JANUARY 1966

A Field Comparison of Helicopter Antiarmor Tactics (U)

by
Stephen B. Forman
Harrison N. Hoppes
Barry M. Kibel
Arthur R. Woods
Research Analysis Corporation
and
Benny E. Edney
US Army Combat Development Command

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FOREWORD

During the periods July–August 1963 and January–February 1964 teams of analysts from Research Analysis Corporation's Field Experiments Division participated in free-play helicopter-reconnaissance experiments with the officers and men of the 2d Sqdn, 4th Cav, 4th Armd Div. In these experiments, helicopter crews were instructed to determine the location and concentration of enemy elements but not to take any opposing elements under simulated fire.

The employment of helicopters in an antiarmor role represents a logical extension of these evaluations of reconnaissance effectiveness. This technical paper presents the results of a two-sided field venture measuring the relative worth of a variety of antiarmor tactics.

Richard E. Tiller
Chief, Field Experiments
Division

ACKNOWLEDGMENTS

The authors gratefully acknowledge the assistance and guidance provided by the officers and men of the 2d Sqdn, 4th Cav, 4th Armd Div during this experiment. Pilots and heliborne infantry were furnished by D Trp (Air Cav) and ground vehicles and personnel by A, B, and C Trps of the 2d Sqdn, 4th Cav.

The interest of Lt Gen Louis Truman, CG, VII Corps; Maj Gen Alexander Surles Jr, CG, 4th Armd Div; and Brig Gen Robert Glass, ADC, 4th Armd Div, is sincerely appreciated.

The data-recording instrumentation used during this experiment was prepared and serviced by members of RAC's Electro-Mechanical Laboratory. Personnel from the Electro-Mechanical Laboratory who participated in the field activities include: Mr. Paul F. Michelsen (Manager), Mr. Robert E. Shook, Mr. Ronald R. Kessler, Mr. Kenneth R. Diller, Mr. David L. Sauls, and Mr. Joshua Cosden. Members of RAC's Field Experiments Division who contributed to this paper include: Mr. Henry A. Romberg Jr, Mrs. Muriel B. Tullner, and Mrs. Ruth S. Eanet. The authors especially appreciate the assistance of Mr. Robert A. Slaybecker in analyzing the data collected and of Mrs. Thelma A. Chesley in preparing the draft manuscript for publication.

This experiment was conducted under the sponsorship of the US Army Combat Developments Command; Col Carroll McFalls Jr, Chief, Field Experimentation and Troop Test Division served as chairman of the Project Advisory Group that provided guidance and direct support.

CONTENTS

Tables

SUMMARY

Problem

To evaluate several helicopter antiarmor concepts against simulated enemy ground employments.

Facts

The Field Experiments Division of Research Analysis Corporation (RAC) is currently studying a variety of Army problems involving tactics and doctrine. A major portion of the Division's field activities have dealt with air-ground interactions.[1-9] Many of these field efforts[3,4,6-8] were conducted near Nürnberg, Germany, with the assistance of D Trp (Air Cav), 2d Sqdn, 4th Cav, 4th Armd Div.

From 6 to 12 Dec 63, D Trp participated in field training exercise (FTX) YELLOW WEDGE, performing tank-killer missions. At the "loss" of 2 UH-1B aircraft, D Trp killer teams were given credit for "destroying" a total of 10 tanks, 14 armored personnel carriers (APCs), 9 wheeled vehicles, and 30 dismounted infantry. In his report describing the employment of armed helicopters against ground targets, the D Trp commanding officer recommended that this concept be made the subject of field test by the team from RAC which is currently working with this unit.

Discussion

During July 1964 a helicopter antiarmor experiment, designed with Project Advisory Group (PAG) guidance, was conducted by RAC analysts with the assistance of personnel from the 2d Sqdn, 4th Cav, 4th Armd Div. This experiment measured the ability of helicopter antiarmor teams to engage targets assumed to have been acquired by reconnaissance elements of the air cavalry troop.

The experimental design employed is summarized in Table 1. The first type of killer team shown consisted of two UH-1B helicopters armed with SS-11 antitank missiles. During missions with this type of team the helicopters simulated firing SS-11 antitank missiles at ground targets whose positions had been reported to the pilots prior to lift-off. The other types of killer teams studied were composed of a combination of ground and aerial elements; in these runs only a single UH-1B helicopter was used. The performances of killer teams

armed with ENTAC antitank missiles and teams with M67 90-mm recoilless rifles were evaluated with the helicopters playing either an active or passive role. On runs with active helicopters (killer-team types 2 and 4), the pilot's mission was to deliver the ENTAC or the recoilless-rifle crews safely, distract the attention of the enemy ground targets from the dismounted elements, assist the dismounted personnel in acquiring enemy targets, simulate suppressive fire when the dismounted killer elements (DKEs) broke contact with the

TABLE 1

Summary of Helicopter Antiarmor Experiment Design

Type of killer team	Antiarmor weapon		Helicopter role	Experimental runs		
	Type	Fired by		Against stationary targets	Against fluid targets	Total
1	SS-11 antitank missile	Helicopter	Engage enemy targets	4	4	8
2	ENTAC antitank missile	Dismounted elements	Ground element delivery, support, and retrieval	4	4	8
3	ENTAC antitank missile	Dismounted elements	Ground element delivery and retrieval only	4	4	8
4	90-mm recoilless rifle	Dismounted elements	Ground element delivery, support, and retrieval	4	4	8
5	90-mm recoilless rifle	Dismounted elements	Ground element delivery and retrieval only	4	4	8
Total				20	20	40

enemy, and rendezvous with his dismounted teammates. On experimental runs with passive helicopters (killer-team types 3 and 5), the pilot merely delivered the heliborne killer elements and retrieved them from prearranged locations. The ground portion of killer-team types 2 to 5 consisted of either a 4-man ENTAC crew or two 2-man recoilless-rifle crews. In all cases the mission of the dismounted crews was to acquire the reported targets and take them under fire within the effective range of the weapons simulated.

During the field experiment, killer teams conducted a total of 20 runs against stationary target complexes and 20 runs against fluid target complexes. On experimental runs against stationary enemy targets, two complexes were positioned in woodlines commanding key objectives. Each complex consisted of two M113 APCs simulating tanks and one 3-man infantry squad providing

security against attack by opposing infantry elements. One of these complexes was designated the "target" complex. The map coordinates of this complex were reported to the killer team; no information was provided to killer-team personnel about the location of any other enemy elements. On experimental runs with fluid complexes, two M113 APCs were used to simulate target tanks in the point of an armor column and three M114A1 command and reconnaissance vehicles were employed to provide route security for the column. The M114A1's cleared woodlines and other potential ambush points ahead of the column.

Prior to the start of each run the antiarmor teams were given detailed briefings. They were allowed complete freedom in determining flight paths, points of dismount, attack tactics, rendezvous locations, and mission duration.

Personnel in the stationary and fluid complexes were instructed to engage all opposing elements acquired. Audible and visual acquisitions of helicopters and dismounted killer-team elements were radioed to other ground vehicles. Infantry was frequently dispatched from the stationary complexes to investigate suspected enemy activity. On runs with fluid target complexes, commanders of the M114A1 scout vehicles, providing route security for the armor column, often sent crew members forward on foot to secure areas in which the M114A1's could not maneuver freely.

To increase the degree of tactical realism still more, gunfire simulators were used by each side. In addition, vehicle crews in the stationary complexes were allowed to camouflage their vehicles with light branches and other natural foliage.

Gun cameras and event-sequence recorders mounted in the helicopter and on ground-complex vehicles were used to obtain data about the acquisitions and firings that occurred during the two-sided action. Data collected by these recording instruments were analyzed in detail using statistical techniques.

As might be expected in simulated tactical engagements in which both sides were allowed substantial freedom in combating opposing elements, a wide range of outcomes was observed. On many of the experimental runs the killer teams were quite successful; on others, killer teams did not acquire enemy targets, were captured prior to firing at enemy targets, fired outside the effective range of their weapons, or established points of ambush after the enemy vehicles had passed by. A summary of killer-team performance is shown in Table 2. Of the 40 experimental runs, on 25, or five-eighths of the total conducted, killer elements were able to fire at one or more enemy tanks within the effective range of their antiarmor weapons. On these 25 potentially successful missions, killer elements fired a total of 65 times at a total of 41 different enemy tank targets. When hit- and kill-probability information was combined with the data for killer-team firings, it was estimated that 20 enemy targets would have been destroyed. Of these 20 expected kills, 4 were scored by SS-11/UH-1 teams, 3 by ENTAC crews with active helicopter support, 2 by ENTAC crews with passive helicopter support, 5 by recoilless-rifle crews with active helicopter assistance, and 6 by recoilless-rifle crews on missions

TABLE 2

Summary of Killer-Team Performance

Team element	Unsuccessful missions					Potentially successful missions	Total missions
	No targets acquired	Dismounted elements intercepted	Too late	Fired out of range	Total		
SS-11/UH-1							
Against stationary targets	1	0	0	0	1	3	4
Against fluid targets	1	0	0	0	1	3	4
ENTAC							
Active helicopter							
Against stationary targets	2	1	0	0	3	1	4
Against fluid targets	0	0	0	0	0	4	4
Passive helicopter							
Against stationary targets	1	0	0	1	2	2	4
Against fluid targets	0	0	2	0	2	2	4
Recoilless rifle							
Active helicopter							
Against stationary targets	1	1	0	0	2	2	4
Against fluid targets	1	1	0	0	2	2	4
Passive helicopter							
Against stationary targets	0	1	0	1	2	2	4
Against fluid targets	0	0	0	0	0	4	4
Total	7	4	2	2	15	25	40

with passive helicopters. Eight of these kills were scored against stationary vehicles and 12 against vehicles in the simulated armor column.

In addition to evaluating killer-team performance against enemy targets, the experimental data collected were also analyzed on the basis of the actions of personnel in the ground complexes against killer-team elements. The total number of times helicopters and DKEs were acquired and taken under fire by all ground-complex elements during killer-team entry, attack, and withdrawal are summarized in Table 3. The comparisons shown in Table 4 were derived from these data. Based on the average number of killer-team elements acquired and taken under fire by ground-complex personnel, it was observed that ground-complex activity was (a) greater against SS-11/UH-1 antiarmor teams than against the other types of killer teams studied, (b) about twice as great against active helicopters as against passive, (c) approximately the same against helicopter-supported DKEs as unsupported DKEs, and (d) far greater against helicopters for vehicles in stationary complexes than in fluid complexes.

Findings

The major findings resulting from a detailed analysis of the data from the RAC antiarmor field experiment are summarized in this section. For the

TABLE 3

Summary of Ground-Complex Activity during Experimental Runs

Ground elements	Activity			
	Helicopters		DKEs	
	Times acquired	Times fired at	Times acquired	Times fired at
Stationary				
Against SS-11/UH-1	156	76	—	—
Against ENTAC				
Active helicopter	81	37	5	3
Passive helicopter	29	15	2	2
Against recoilless rifle				
Active helicopter	47	26	7	4
Passive helicopter	30	6	10	3
Fluid				
Against SS-11/UH-1	50	24	—	—
Against ENTAC				
Active helicopter	31	17	5	3
Passive helicopter	21	14	5	3
Against recoilless rifle				
Active helicopter	15	9	11	9
Passive helicopter	6	4	9	7

TABLE 4

Summary Comparisons of Experimental Variables Studied

Elements compared	Mean acquisitions per helicopter per run		Mean firings per run	
	Against helicopters	Against DKEs	Against helicopters	Against DKEs
SS-11/UH-1 vs ENTAC vs recoilless rifle team	15 v 10 v 6	0 v 1 v 2	7 v 5 v 3	0 v 1 v 2
Active vs passive helicopters	11 v 5	2 v 2	6 v 2	1 v 1
Stationary vs fluid targets	14 v 6	1 v 2	6 v 3	1 v 2

SUMMARY

particular terrain, force structures, tactical situations, and weapons-simulation techniques employed it was observed that:

(1) The SS-11/UH-1 crews encountered considerable difficulty in acquiring enemy target vehicles. None of the SS-11/UH-1 teams detected targets on their initial attempts against vehicles in the stationary complexes and only half were able to launch missiles against fluid target vehicles on their initial firing passes. On all eight missions involving SS-11/UH-1 teams at least one helicopter was taken under fire by enemy ground personnel prior to the time the first SS-11 missile was launched.

(2) Helicopter support of DKEs did not lead to a noticeable improvement in their performance. During the attack phase of the missions observed, dismounted elements who did not receive active assistance fired at as many targets and as many times per target as dismounted elements who received helicopter support. Moreover, helicopter crews usually did not arrive at the scene of the attack in time to provide effective suppressive fire during DKE withdrawal. On the other hand, helicopter crews who supported dismounted elements were subjected to considerably more enemy fire than helicopters used solely to deliver and retrieve dismounted elements.

(3) Antiarmor teams were markedly more effective in attacking vehicles with a movement mission than in attacking the stationary target complexes; 60 percent of the target kills expected were scored against fluid vehicles. For the 40 missions observed, helicopters were fired on twice as often on missions against the stationary complexes as on missions against fluid enemy vehicles.

A Field Comparison of Helicopter Antiarmor Tactics

ABBREVIATIONS

APC	armored personnel carrier
DKEs	dismounted killer elements
ENTAC	antitank guided-missile
FTX	field training exercise
NCO	noncommissioned officer
PAG	Project Advisory Group

INTRODUCTION

Since March 1963 teams of analysts from RAC's Field Experiments Division (formerly the Combat Developments Division) have been studying helicopter operations with the assistance of the officers and men of D Trp (Air Cav), 2d Sqdn, 4th Cav, 4th Armd Div. During March and April 1963 RAC analysts gained familiarity with helicopter operations by participating in troop-level and squadron-level field exercises. Between June 1963 and June 1964 a total of eight field ventures involving D Trp personnel was conducted. These field evaluations of air-ground interactions are summarized in Table 5. All were completed within the

TABLE 5

Summary of RAC Field Activities with D Trp, 2d Sqdn, 4th Cav, 4th Armd Div

Date	Description of field experiment	Publication presenting experimental results
Jun 63	Gunner tracking ability against helicopters employing evasive maneuvers	RAC-TP-136
Jun 63	Tracking capability of internally mounted tank machinegun against helicopters	RAC-TP-124
Jul 63	Summer-phase helicopter reconnaissance	RAC-T-433
Jul 63	Evaluation of helicopter pop-up tactics	RAC-T-464
Jan 64	Winter-phase helicopter reconnaissance	RAC-T-446
Jan 64	Tracking capability of M114A1 scout vehicle against helicopters	RAC-TP-124
Feb 64	Evaluation of helicopter pop-up tactics	RAC-T-464
Jun 64	Antiarmor tactics involving helicopters	RAC-TP-189

normal training activities of the 2d Sqdn, 4th Cav. The experience accumulated by RAC analysts during the first seven experiments provided the necessary expertise to conduct a two-sided evaluation of antiarmor tactics in which participants on each side were allowed substantial freedom in combating opposing elements.

D Trp pilots were quite proficient in executing a variety of tank hunter-killer missions. Following the organization of D Trp in July 1962, the first air cavalry troop in Seventh Army, D Trp pilots underwent intensive training in all phases of air cavalry operations. By June 1964 D Trp pilots had completed two

cycles of crew and unit training, conducted a 4-week school on gunnery and tactics for helicopter pilots in all Seventh Army divisions and armored cavalry regiments, participated in two division-level FTXs, and presented several demonstrations of their antiarmor capabilities.

For FTX YELLOW WEDGE, conducted 6--12 Dec 63, D Trp was directed to organize and test a variety of tank-killer teams using helicopters in an offensive role. Two general types of killer teams organized were (a) those utilizing the helicopter as an aerial platform for launching antitank guided missiles and (b) those utilizing the helicopter to transport infantry equipped with antitank weapons to ambush points and then provide diversionary or suppressive fire in support of the dismounted infantry. A brief summary of the outcomes of eight umpire-assessed D Trp missions during FTX YELLOW WEDGE is provided in Table 6. From this table it can be seen that surprise was achieved on seven

TABLE 6

Summary of Evaluations for Eight D Trp Tank-Killer Missions during FTX YELLOW WEDGE

Mission phase	Performance measure	Outcomes observed
Planning	Times adequate and timely information was provided to killer teams	6 of 8 missions
	Time available to plan mission, mean	8 min
Movement to contact	Depth of penetration of enemy line, mean	3.5 km
	Depth of penetration of enemy line, median	0.5 km
	Times nap-of-the-earth flight techniques used	8 of 8 missions
	Times helicopters detected	2 of 8 missions
	Times helicopters taken under fire	1 of 8 missions
	Time from lift-off to engagement, mean	20 min
Engagement	Times surprise achieved	7 of 8 missions
	Tanks acquired, total	30
	Tanks destroyed, estimated	10
	APCs acquired, total	18
	APCs destroyed, estimated	14
	Dismounted infantry acquired, total	100
	Dismounted infantry destroyed, estimated	30
	Truck targets acquired, total	22
	Trucks destroyed, estimated	9
	Helicopters destroyed, estimated	2
	Duration of engagement, mean	2 min

of eight antiarmor missions. Tank-killer teams received credit for destroying 10 tanks, 14 APCs, 30 dismounted APC infantrymen, and 9 trucks that were selected as targets. D Trp losses were estimated to be 2 aircraft.

Because of the interest at all levels within US Seventh Army and the study's Project Advisory Group (PAG), an evaluation of antiarmor tactics employing helicopters both as firing platforms and in support of infantry teammates was conducted. From the outset it was apparent that an examination of the combined effectiveness of the light observation helicopters (OH-13's) and attack helicopters

(UH-1B's) forming a "hunter-killer" team would be beyond the capability of RAC analysts to complete within the squadron's normal training schedule. Consequently it was decided to limit the June 1964 field experiment to an evaluation of the tank-killer portion of the total missions. It was also decided to provide the killer elements with perfect intelligence concerning the location and direction of movement of the enemy vehicles designated as targets. Because RAC's summer- and winter-phase reconnaissance experiments[7,8] indicated that difficulties in acquiring targets, specifying map coordinates, keeping enemy vehicles under surveillance without becoming a casualty, and providing timely intelligence would be encountered by helicopter "hunter" elements operating in the type of terrain utilized, the performance of the killer teams during the June experiment should be considered indicative of the upper limit of their effectiveness in situations of the type studied.

EXPERIMENTAL DESIGN

Like the summer- and winter-phase reconnaissance endeavors, the antiarmor evaluation was designed to balance the experimental control required for statistical validity against the tactical realism obtained from two-sided free-play field experiments.

TABLE 7

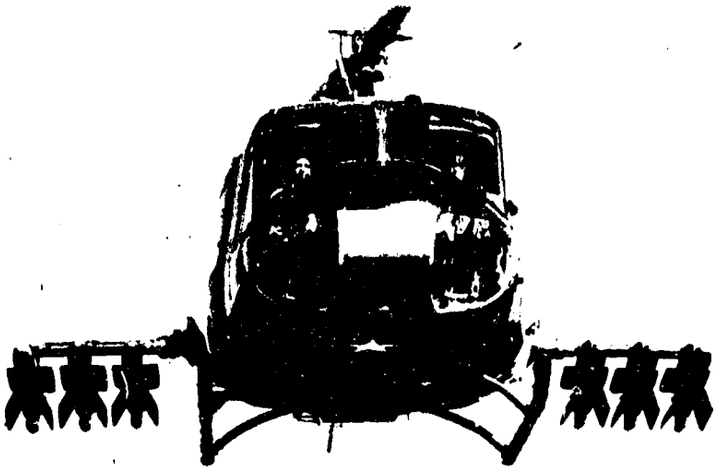
Test Conditions for Antiarmor Experiment

Antiarmor weapon	Element firing weapon	Helicopter participation	Missions		
			Against stationary targets	Against fluid targets	Total
SS-11 antitank missile	Helicopter	Weapons platform	4	4	8
ENTAC antitank missile	Dismounted elements	Active support	4	4	8
ENTAC antitank missile	Dismounted elements	Passive support	4	4	8
90-mm recoilless rifle	Dismounted elements	Active support	4	4	8
90-mm recoilless rifle	Dismounted elements	Passive support	4	4	8
Total			20	20	40

The experimental design employed during the antiarmor field study is shown in Table 7. As is indicated, five types of killer teams using three antiarmor weapons were included in the analysis. The weapon systems considered are illustrated in Fig. 1. Table 8 summarizes the basic characteristics of SS-11 wire-guided antitank missiles, ENTAC wire-guided antitank missiles, and M67 90-mm recoilless rifles.

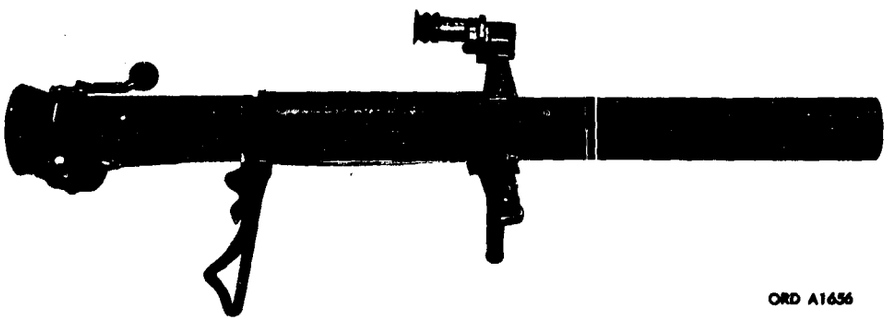
WEAPONS EMPLOYED

The SS-11 (redesignated the XM-22) is a lightweight remote-controlled wire-guided missile. Although primarily an antitank weapon, it can be used



a. SS-11/UH-1 Weapons System

b. ENTAC Antitank Guided Missile



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c. M67 90-mm Recoilless Rifle

Fig. 1—Antiarmor Weapons Included in Field Experiment

TABLE 8

Summary of Weapons Characteristics

Weapon, characteristic	Measurement
SS-11 antitank guided missile	
Missile	
Weight	62.8 lb
Weight, in container	156.5 lb
Flight speed	0–180 m/sec
Maximum practical range	3500 m
Minimum practical range	500 m
Warhead size	125-mm HEAT
Launching, guidance, and test equipment, weight	
Launcher, each	23.0 lb
Launcher support boom	33.9 lb
Control box	5.0 lb
Command box, type V	6.6 lb
Signal generator, T9C	29.5 lb
Selection box	10.5 lb
Sight, antioscillation, XM-55	10.0 lb
Sight, MK-8	6.0 lb
Circuit tester	15.2 lb
Missile battery tester	9.4 lb
ENTAC antitank guided missile	
Missile	
Weight	27 lb
Weight, including launcher	37.5 lb
Cruising speed	80 m/sec
Maximum practical range	2000 m
Minimum practical range	400 m
Warhead size	130-mm HEAT
Guidance equipment, weight	
Control unit TR-10	28.4 lb
Selection box	10.9 lb
Battery	3.0 lb
100-m cable, reel, stand	47.2 lb
10-m cable	3.5 lb
Circuit tester	5.5 lb
90-mm recoilless rifle M67	
Rifle	
Weight	35 lb
Length	53 in.
Rifling	Right hand twist
Firing mechanism	Percussion
Estimated usable life, tube	2000 rds
Ammunition	HEAT
Weight, 1 rd ammunition	9.3 lb
Muzzle velocity, HEAT	700 fps
Effective range, HEAT	400 m

effectively against personnel, gun emplacements, strong points, roadblocks, and fortifications.[10] In the SS-11/UH-1 weapons system shown in Fig. 1 the missile is launched by a gunner sitting next to the helicopter pilot. The gunner controls the path of the missile during its flight; movements of the gunner's

control stick are transmitted as electrical signals through wires that unwind from the missile to guidance blades, regulating the deflection of missile exhaust gases. During the flight of the missile the gunner's line of sight to the target must be unobstructed and the path of the SS-11 must be free from trees, brush, and other obstacles that might detonate the missile or alter its trajectory. The SS-11 is equipped with an inertia-type of fuze that detonates the warhead of the missile on impact. The ranges of engagement at which the SS-11 is most effective exceed 1000 m because of difficulties in visually acquiring the missile in the gunner's tracking sight during early flight.

The ENTAC is a remote-controlled guided missile designed specifically for ground-to-ground firings.[11] Weighing less than half as much as the SS-11, ENTAC missiles with associated launching and guidance equipment are relatively easy to transport and prepare for firing from ground positions. The maximum practical range and velocity of flight are somewhat less for the ENTAC than for the SS-11 (see Table 8). Both missiles, however, are based on the same guidance principles and both may be employed against armored vehicles, gun emplacements, roadblocks, and fortifications.

The 90-mm recoilless rifle, M67, is the current medium antitank assault weapon.[12] It is a lightweight portable weapon designed to be fired from the shoulder or from a tripod ground mount. The M67 recoilless rifle, a direct fire weapon, is tactically employed by infantry against tanks and field fortifications at ranges of 15 to 400 m.

These three weapons represent a broad range of antiarmor capabilities. The SS-11/UH-1 weapons system provides the capability of engaging enemy armor from highly mobile aerial platforms. The ENTAC system, when transported by helicopter, furnishes the opportunity of establishing mobile ambush points against fluid targets at ranges between 400 and 2000 m; the air-delivered recoilless-rifle crews provide a similar capability against targets at engagement ranges of less than 400 m. The SS-11 and ENTAC systems are sophisticated weapons requiring highly developed skills to operate effectively; the 90-mm recoilless rifle, on the other hand, is a relatively simple weapon requiring little crew training. The ENTAC system is also comparatively bulky, requiring about twice as much helicopter payload space as each 90-mm recoilless-rifle team. On the June antiarmor experiment, DKEs consisted of either one 4-man ENTAC crew or two 2-man recoilless-rifle crews. Two members of the 4-man ENTAC crew and one member of each 2-man recoilless-rifle crew were RAC data collectors simulating the roles of the ammunition bearers or handlers.

HELICOPTER ROLES

In addition to considering a variety of weapons during the experiment a number of helicopter roles were also evaluated. During SS-11 runs, two UH-1B helicopters generally functioned as an attack team, acquiring the designated targets and taking them under simulated fire. On runs with "active" helicopters involving DKEs, the mission of the helicopter pilots was to deliver the ground elements to safe and advantageous positions, divert the attention of ground-target personnel from the dismounted elements whenever this appeared appropriate,

provide simulated 2.75-in. rocket fire to cover the withdrawal of the dismounted elements, and then rendezvous with their dismounted teammates. On runs with "passive" helicopters, on the other hand, the helicopter pilots merely transported the ground portion of the DKEs and retrieved them from prearranged locations. Single UH-1B helicopters were used on all runs involving DKEs.

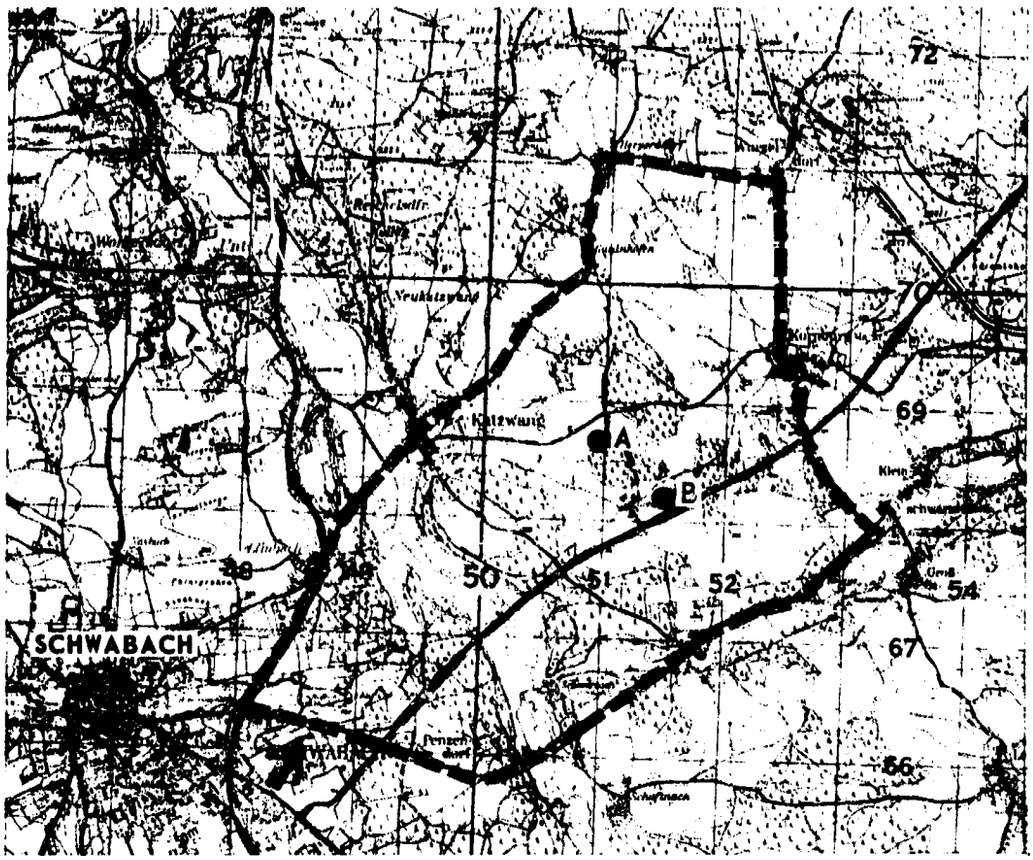
TARGET COMPLEXES

Two types of ground targets were included in the analysis. On "stationary" runs, two complexes were positioned in woodlines that commanded such key military objectives as towns or the Autobahn. Each complex consisted of two M113 APCs with their crews and one infantry squad, consisting of three men armed with a bipod-mounted 7.62-mm M60 machinegun. APCs were used to simulate tanks because of the maneuver damage likely to occur from the employment of tanks. APC crews were allowed to use natural foliage to conceal the location of their vehicles. The noncommissioned officer (NCO) in charge of each stationary complex was permitted to dispatch the infantry squad to investigate areas of suspected enemy activity. The four pieces of terrain chosen for the stationary runs and the location of the APCs in the two complexes (A and B) are illustrated in Fig. 2.

On "moving" runs, five vehicles formed a fluid ground complex. Two M113 APCs designated as targets simulated the point of an armor column with three M114A1 scout vehicles providing route security. Movement of the APCs was restricted to the path outlined in Fig. 3. The M114A1's operated one terrain feature forward of the column clearing woodlines and other potential ambush points before allowing the column to advance. Security-vehicle commanders were given the option of dismounting crew members to search areas in which the vehicles could not maneuver freely.

Personnel in the stationary and moving complexes did not know when enemy missions were initiated and completed or what type of enemy air-ground activity to expect.

During the antiarmor experiment a total of 40 runs was conducted. These runs were divided evenly between stationary and moving scenarios. Each of the five killer tactics was examined a total of eight times. Four experimental runs were conducted for each killer-team ground-target combination, which was considered the minimum number required for statistical validity and the maximum number that could be completed within the 3-week period available for the conduct of the experiment, based on the experience of the summer- and winter-phase reconnaissance experiments.

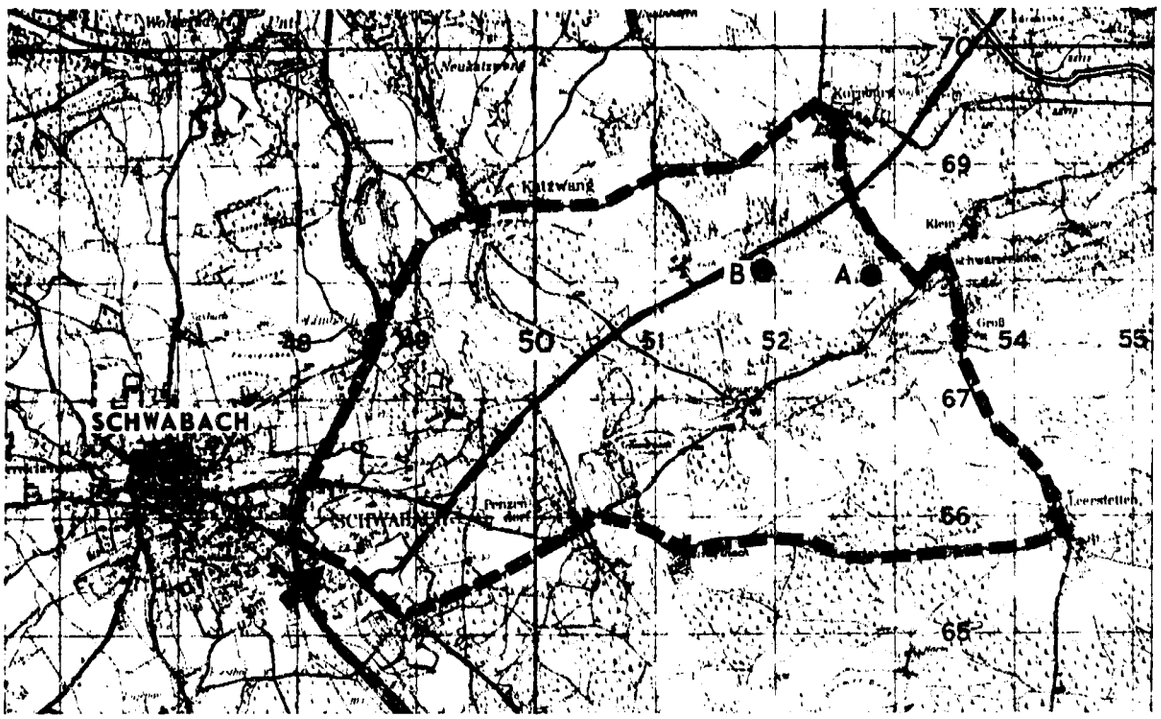


a. Terrain 1

Fig. 2—Location of Stationary Complexes

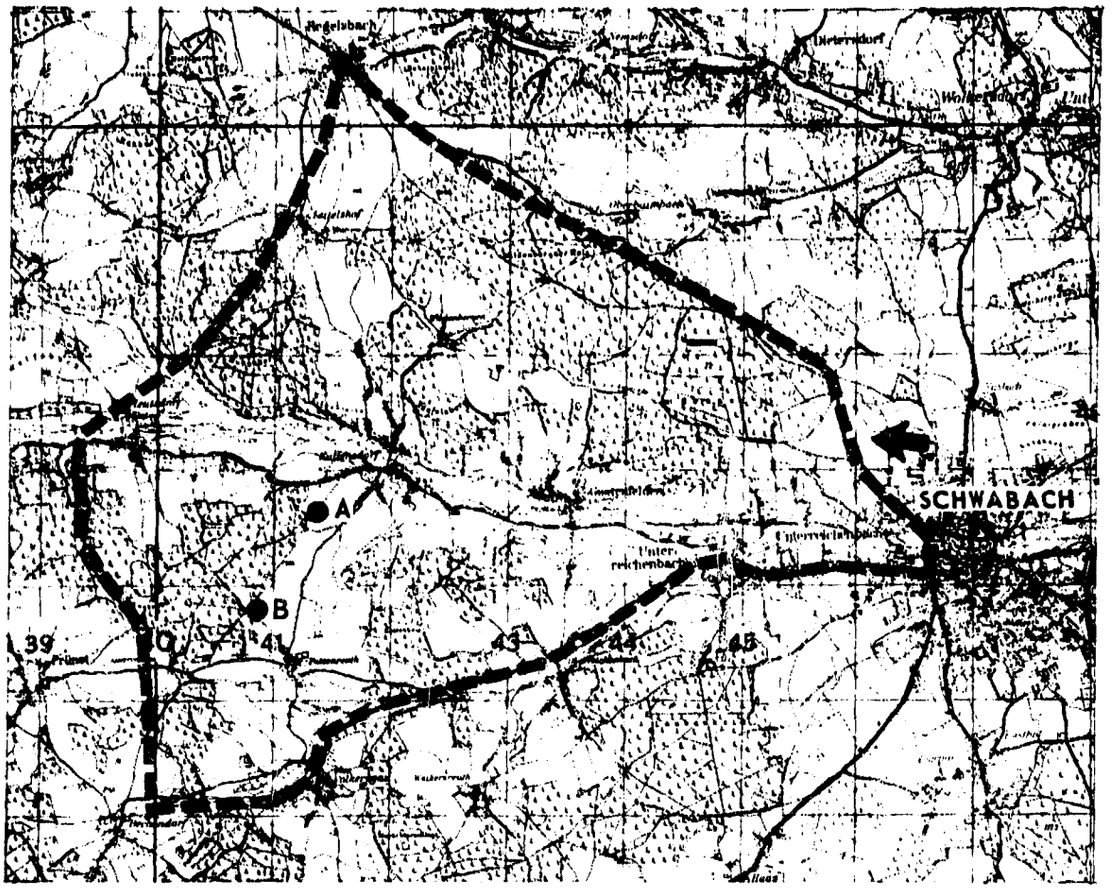
➡ Direction of attack ———Mission area

A, target complex; B, unreported complex



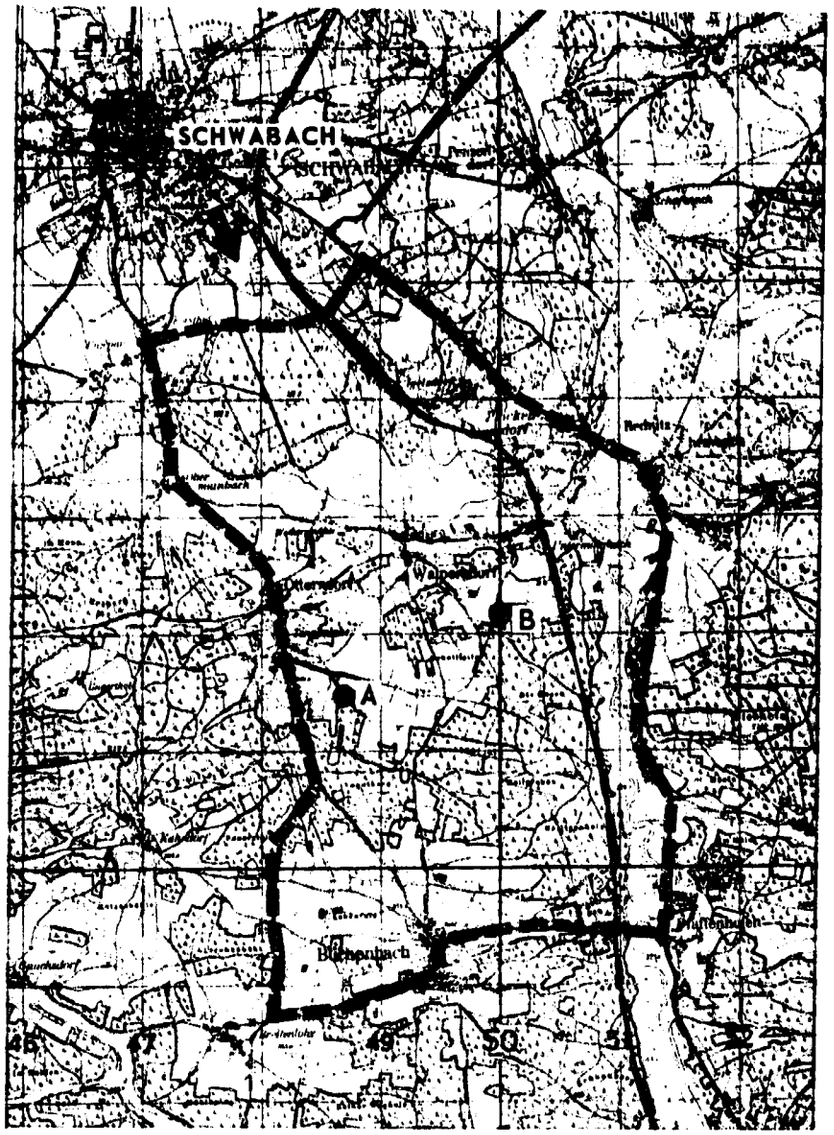
b. Terrain 2

Fig. 2—Continued



c. Terrain 3

Fig. 2—Continued



d. Terrain 4

Fig. 2—Continued

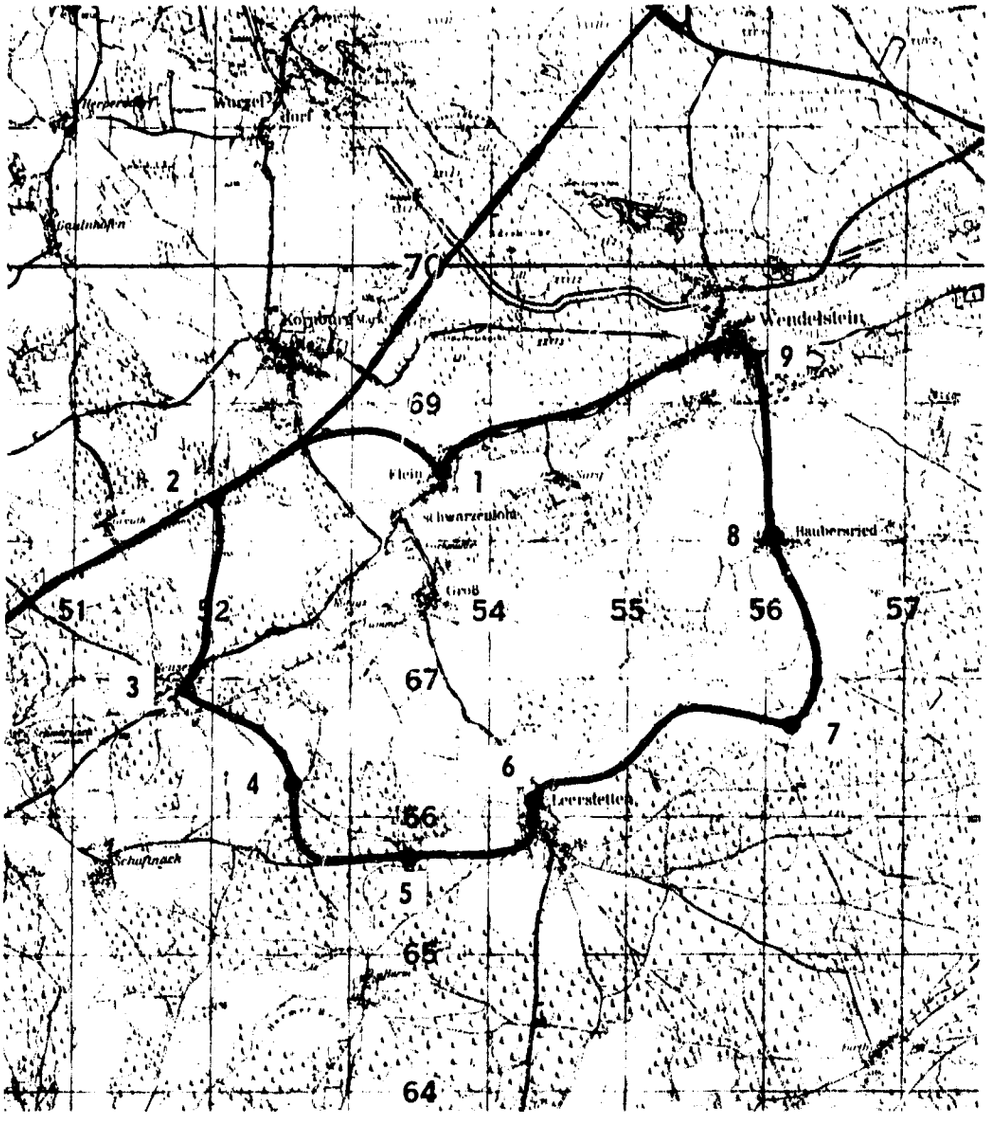


Fig. 3—Terrain Used for All Experimental Runs Involving Fluid Complexes

● Checkpoints

EXPERIMENTAL PROCEDURE

This section provides details about the conduct of the experimental runs, type of data collected, and methods by which these data were obtained. Because of differences in tactical employments and data-collection techniques, the procedures for ground targets and killer teams will be discussed separately.

GROUND TARGETS

Stationary Runs

Personnel manning the ground complexes were selected from A, B, and C Trps of the 2d Sqdn. Prior to departure from Schwabach, ground-complex personnel were given a detailed briefing on their overall mission and individual assignments. They were informed that enemy ground and aerial activity might be encountered and were instructed to take all enemy elements acquired under fire. Particular emphasis was placed on responding rapidly to enemy sightings and relaying sighting information by radio to other friendly elements. On stationary runs, ground personnel were divided into two complexes, each consisting of two M113 APCs and one infantry squad. The crew of each APC consisted of one NCO who served as vehicle commander and one driver who participated as an observer during the runs. Each infantry squad consisted of two enlisted men and one NCO.

During the briefing, gun cameras were mounted on the .50-cal main armament of the APCs. In addition the bipod-mounted 7.62-mm machineguns used by the infantry squads were also instrumented with gun cameras (see Fig. 4). These cameras served the dual purpose of furnishing information on the accuracy of weapon lay at time of fire and providing an added stimulus to participate in the two-sided action. The cameras used were AN-N6 16-mm movie cameras with 3-in. lenses. Special mounts to attach the cameras to the weapons were designed to avoid any change in the handling characteristics of the weapon. A camera-mounted .50-cal machinegun used on the M113 APC is shown in Fig. 5.

After the briefing the vehicles moved in column formation to the designated area. During each of the four scenarios with stationary APCs the vehicles were positioned in the edge of woods. The exact positioning of the vehicles and infantry squad was determined from advice provided by the military participants. In all cases the ground vehicles representing delaying elements were stationed to guard key terrain features and logical avenues of enemy infiltration and advance. Ground crews were allowed to camouflage their vehicles with a limited

Fig. 4—Camera-Mounted 7.62-mm M60 Machinegun

amount of natural foliage. The appearance of a typical stationary target is illustrated in Fig. 6.

An Esterline-Angus event-sequence recorder was installed at a central point in each stationary complex to record data concerning acquisitions and firings. Wires were connected from the event recorder to the triggers of each of the M113 APC .50-cal machineguns and to a push button at each vehicle location to permit instantaneous data input to the central control point. When an enemy helicopter or dismounted infantryman was acquired by a ground-vehicle crew, a RAC analyst at the vehicle indicated this event by depressing a hand-held push button two times, causing the appropriate pen on the recorder to register two blips. When the .50-cal machinegun trigger was pressed, another pen on the recorder was activated and remained displaced until the trigger was released. When the enemy element disappeared from view the APC commander or driver-observer would announce "out of sight" and the RAC analyst noted this event by recording four blips on the pen recorder. A typical sequence of events is illustrated in Fig. 7.

Data recorded at the two stationary complexes were correlated through periodic time checks between the RAC analysts operating the pen recorders. The speed of the paper tape on each recorder was constant but might vary from another recorder by 2 percent or more. A linear correlation factor was applied to relate all data to a single recording rate. All time data reconstructed in this manner were rounded to the nearest second.

Data forms, which included a detailed sketch of the terrain visible from each stationary complex, were given to the RAC analysts at the vehicles (see Fig. 8). On acquiring a killer-team element, the analyst drew its path on the

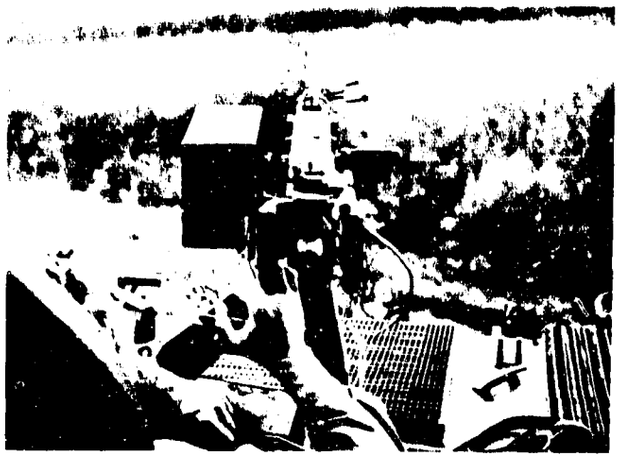
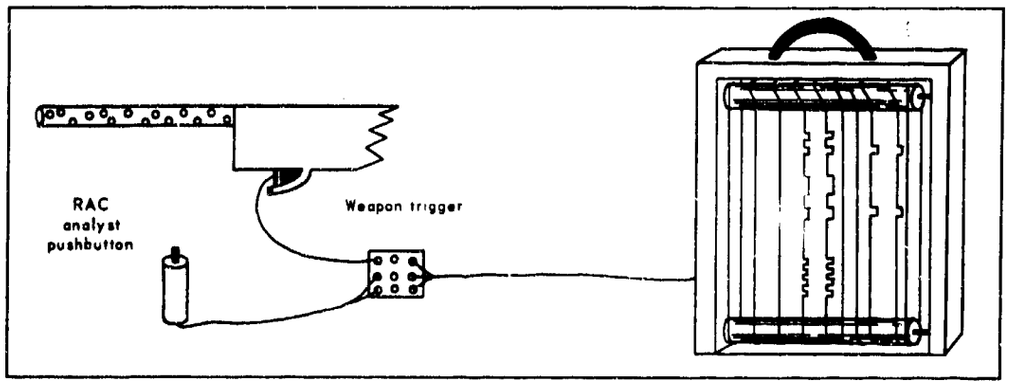
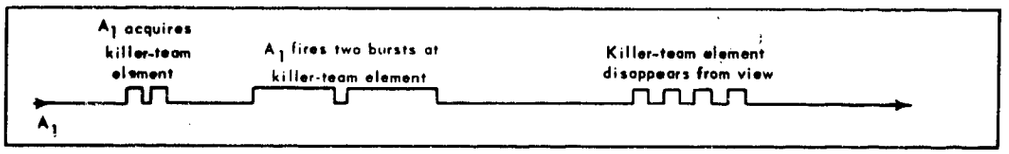


Fig. 5—M113 APC .50-cal Machinegun Camera Mount

Fig. 6—Camouflaged Target Vehicle Positioned in Edge of Woods



a. Method of Recording



b. Typical Sequence

Fig. 7—Illustration of Pen-Recorder Data Collection

terrain diagram provided. At the conclusion of each run the analyst questioned the vehicle crew to determine the positions on his sketch at which the enemy was sighted and taken under fire. Supplementary information, often of a qualitative nature, was also recorded on the data form.

The NCO in charge of each ground complex frequently dispatched his infantry squad to investigate suspected helicopter landings. The infantry dispatched were accompanied by a RAC data collector who started a stopwatch when a killer element was acquired and another when the killer element was taken under fire. After the data collector had returned to his central control point, the elapsed stopwatch times were recorded on the moving Esterline-Angus paper and a notation made to advance the time of the infantry sighting and fire in the event sequence by the amount of elapsed times indicated on the stopwatches at the moment of data transfer to the Esterline-Angus records.

APC crews and infantry squads were also equipped with 12-gage gunfire simulators that delivered a loud report and produced a large puff of smoke. A fluid ground vehicle firing at a helicopter during an overflight is illustrated in Fig. 9.

Moving Runs

Two M113 APCs and three M114A1 scout vehicles were employed as ground targets on each of the 20 fluid runs. The vehicle crews had been instructed that enemy ground and aerial action could be expected. Although the APCs, simulating the point of an armor column, were confined to the roads indicated in Fig. 3, the M114A1's providing route security were allowed considerable freedom of movement. The security vehicles operated one terrain feature forward of the column, attempting to clear potential enemy ambush points before the column

GROUND COMPLEX A
DAY TWO

SITE_____

DATA COLLECTOR _____ RUN NO._____

TOTAL NO. OF SIGHTINGS_____ TOTAL NO. OF FIRINGS_____

CREW ALERTNESS
(CHECK ONE)

☐ good ☐ avg ☐ poor

NO. OF TIMES TARGET FIRST

SEEN ☐ HEARD ☐

ADDITIONAL COMMENTS _____

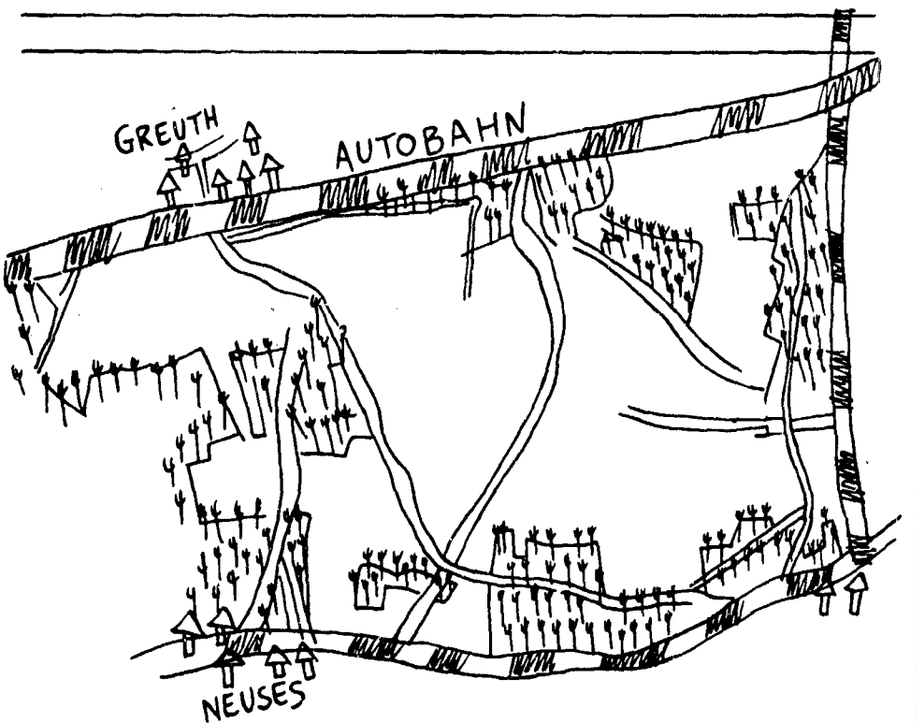


Fig. 8—Data Form Used by Ground-Complex Elements for Stationary Runs

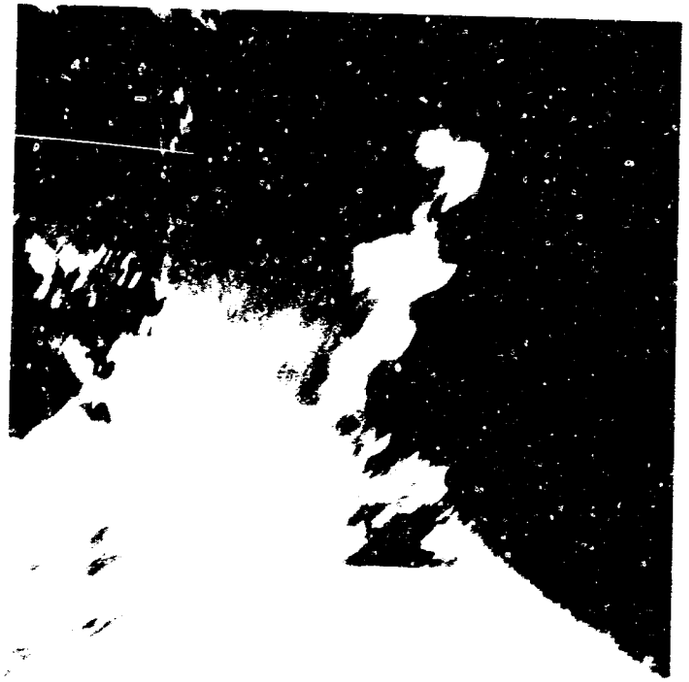


Fig. 9—Simulated Ground Fire at Helicopter

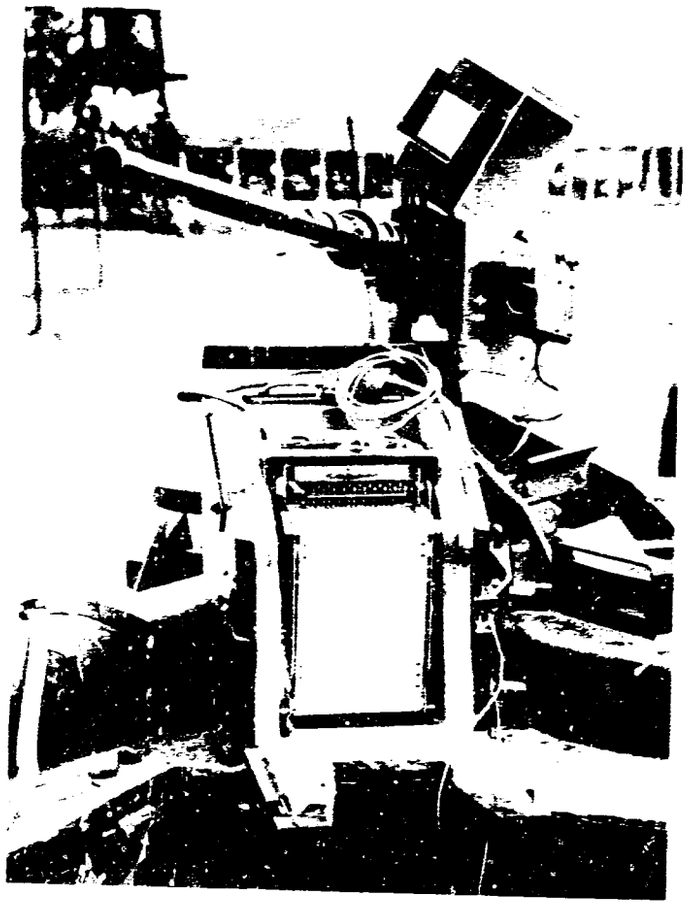
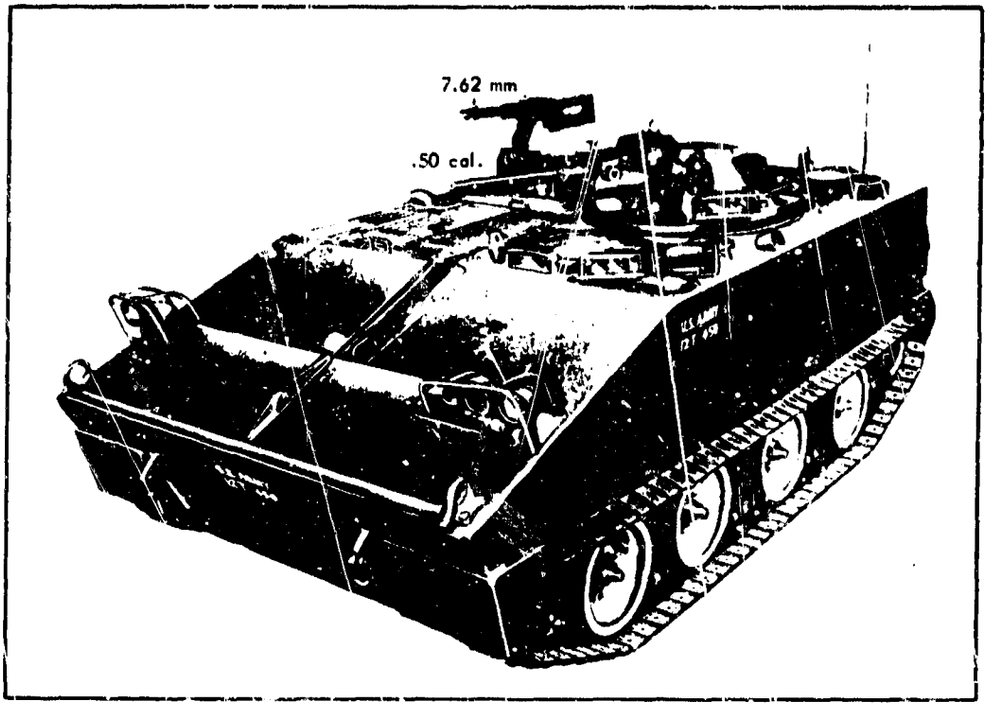


Fig. 10—M113 APC Data Collection Instrumentation

advanced. Security-vehicle commanders were allowed to dismount crew members to search areas in which the M114A1's could not maneuver freely or without causing considerable damage. Towns along the route of march were considered off limits to DKEs attempting to establish ambush points.

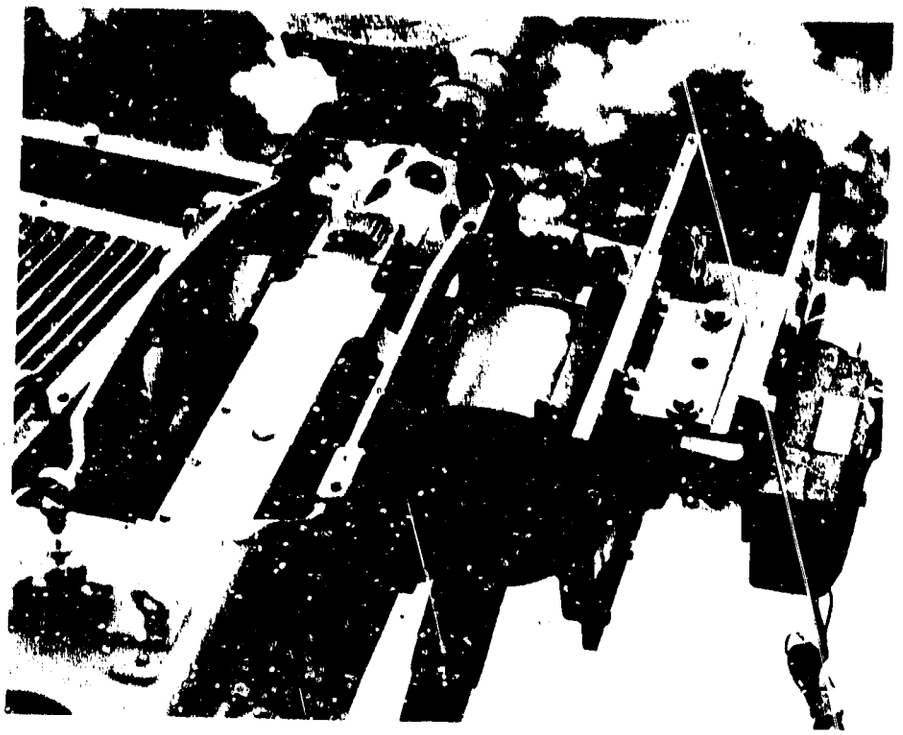
Each M113 and M114A1 was instrumented with an event-sequence recorder and gun-camera equipment. Data-recording instruments mounted on M113 APCs are shown in Fig. 10. In addition to installing an event recorder in each M114A1, gun cameras were placed on both the hand-cranked .50-cal main armament of the scout vehicle and the pedestal-mounted 7.62-mm machinegun. Location of the cameras and close-ups of the camera mounts are depicted in Fig. 11.

Data-recording procedures were similar to those used on the stationary runs. The Esterline-Angus recorders on all five fluid ground vehicles were synchronized before and after each run. Data concerning times of fire were automatically recorded on these instruments whenever the trigger of a weapon was depressed by a gunner. A RAC analyst riding in each vehicle pressed a hand-held button to record sightings by his vehicle crew; in addition, he filled out a data form (see Fig. 12). Shotgun blanks were detonated whenever a killer-team element was taken under fire.

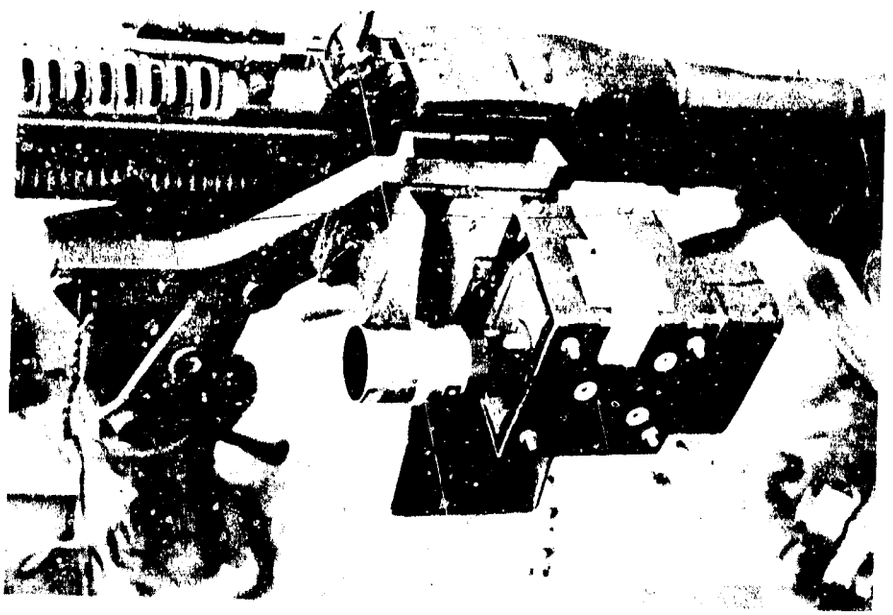


a. Location of Mounts on Vehicle

Fig. 11—M114A1 Scout Vehicle with Machinegun Camera Mounts



b. Close-up of .50-cal Machinegun Camera Mount



c. Close-up of 7.62-mm Machinegun Camera Mount

Fig. 11—Continued

MOVING COMPLEX DATA FORM

VEHICLE _____

DATA COLLECTOR _____ RUN NO. _____

TOTAL NO. OF SIGHTINGS _____

TOTAL NO. OF FIRINGS _____

CREW ALERTNESS (CHECK ONE)

☐ good ☐ avg ☐ poor

NO. OF TIMES TARGET FIRST

SEEN ☐ HEARD ☐

ZERO PICTURE :

SIGHTING	YOUR WATCH TIME	CO-ORD	DID YOU FIRE? .50 cal	.30 cal
1				
2.				
3				
4				
5				
6				

Additional comments _____

Fig. 12—Data Form Used by Ground-Complex Elements for Moving Runs

KILLER TEAMS

Helicopters Firing SS-11 Missiles

Before the beginning of each SS-11 run, helicopter crews were given a detailed briefing about their mission, the location of friendly phase lines, and the reported position of the enemy-complex vehicles. On stationary runs the vehicles in ground complex A were designated as targets and the map coordinates of this complex specified to the nearest 100 m; the location of other enemy vehicles was not provided. On moving runs it was assumed that a friendly light observation helicopter was able to keep the column under surveillance; pilots received the map coordinates of the column at any time during the run that this information was requested. During the mission briefing, helicopter crews were also informed that other enemy elements were suspected to be present within the attack area but that intelligence sources had not yet determined their location(s).

Two UH-1B helicopters were scheduled for each run involving simulated SS-11 firings. The use of pairs of UH-1B's was consistent with military advice that indicated that helicopters armed with wire-guided missiles would seldom, if ever, be dispatched individually. When approaching their targets and executing tactical withdrawals the pilots flew nap of the earth taking full advantage of the terrain to gain concealment from enemy observation and fire. The two helicopter crews forming an SS-11/UH-1 killer team were allowed complete freedom in coordinating their attacks; generally they staggered their attacks from different angles of approach. The pilots were also given the option of making one or two firing passes per aircraft per run. During simulated missile firings, the pilots used the technique of "flying down the wire," i.e., flying directly at the target at reduced air speed.

Data recording equipment in the SS-11/UH-1 helicopter consisted of event-timing instruments, gun cameras, and missile flight-time simulators. The missile flight-time simulator, shown in Fig. 13, was a device that indicated the duration of SS-11 flight times at various attack ranges. On receiving an announced range and fire command from the SS-11 gunner, the RAC analyst occupying the jump seat between the pilot and gunner depressed the button on the flight-time simulator corresponding to the estimated attack range rounded to the nearest 500-m interval. Depressing the button caused a light in front of the pilot to be illuminated for the duration of the SS-11 flight. After the light went out, indicating that the missile had reached the target, the pilot terminated his forward flight by executing an evasive maneuver. A gun camera mounted next to the gunner's sight photographed the target during the period of time corresponding to missile flight to determine whether the target was within the gunner's field of view at the moment of missile impact. The RAC analyst in each helicopter recorded times of target acquisition, estimated ranges of initial acquisition and fire, and ground-target location and defensive action. Time information recorded in the helicopters was correlated with that recorded at the ground sites through periodic countdown time checks.

Dismounted Ground Elements

The briefings presented to the killer teams having heliborne infantry were similar to those given to the SS-11/UH-1 teams. Before lift-off, killer teams

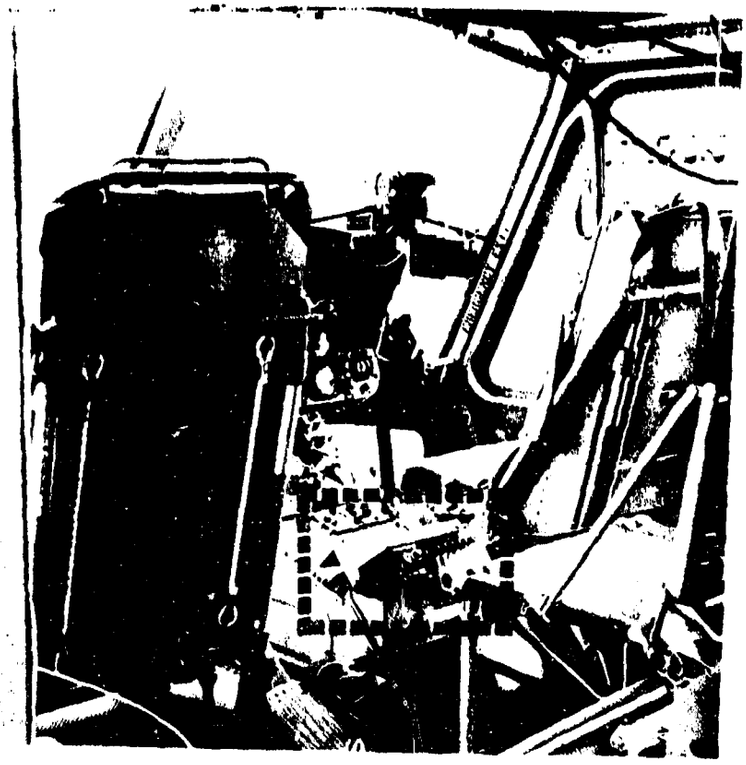


Fig. 13—Helicopter SS-11 Missile Flight-Time Simulator

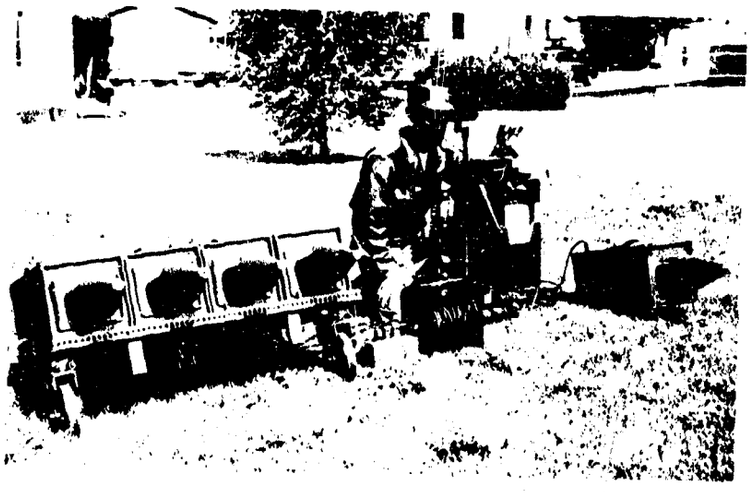


Fig. 14—Simulated ENTAC Weapons System

with ENTAC or recoilless-rifle elements engaged in a thorough map study to select landing zones, discuss the attack phase of the mission, and decide on rendezvous locations. ENTAC elements were especially concerned with finding a tactically sound firing position that offered line of sight to the targets. Recoilless-rifle crews, on the other hand, were more interested in selecting avenues of approach or ambush points that provided the opportunity to come within 400 m of the enemy and still afforded suitable escape routes.

After lift-off the helicopter pilot employed nap-of-the-earth flight techniques to deliver his infantry elements to the prearranged positions. On runs with an active helicopter the pilot often made diversionary landings before and after dismounting his teammates in an attempt to confuse enemy elements that might have visually or audibly acquired the helicopter. Active helicopters also supported their teammates by attempting to provide suppressive fire as the DKEs broke contact with the enemy. On receiving a radio-transmitted request from the ground-element leader, the helicopter pilot simulated 2.75-in. rocket fire on the enemy target vehicles. On passive missions the helicopter pilot was instructed to withdraw to friendly territory and wait until the dismounted elements established radio contact to request pickup.

After delivery the DKEs proceeded on foot to the preselected attack positions. Each ENTAC crew consisted of two infantrymen accompanied by two RAC data collectors simulating the ammunition handlers. ENTAC acquisitions and firings were recorded on an Esterline-Angus instrument built into a simulated ENTAC weapons system (see Fig. 14). Before the ENTAC crew was allowed to engage an enemy target the missiles had to be wired to the guidance and control station according to the operating instructions specified in training manuals.[13] Each ENTAC firing was simulated by three 12-gage shotgun blanks fired in rapid succession. The ENTAC squad leader was equipped with a PRC-25 radio.

Two recoilless-rifle crews were employed on all missions involving this antiarmor weapon. Each crew consisted of one infantryman equipped with an M67 90-mm recoilless rifle and one RAC data collector simulating the ammunition bearer. The RAC analyst collected acquisition and firing information and recorded the crew's attack and withdrawal routes on a 1:25,000 map. Time data were obtained from stopwatches and were recorded using procedures similar to those followed by RAC analysts accompanying the infantry elements protecting the stationary ground complexes. Each recoilless-rifle round fired was simulated by detonating a 12-gage shotgun blank.

One RAC analyst remained in the helicopter on each mission involving dismounted ground elements. This analyst recorded takeoff times, weather, and other environmental conditions during the flights; map coordinates of the landing zones and pickup points; times of ground-element departure and return to the helicopter; and acquisition and firing data for the helicopter on active runs. He also plotted the flight path of the helicopter and took notes that aided in the interpretation of the other data recorded. To assist in recording data of a qualitative nature, all RAC analysts accompanying the killer elements carried miniature tape recorders equipped with throat microphones.

DATA ANALYSIS

GENERAL

This section presents summary data from the antiarmor runs, descriptions of the performance measures considered, analyses of killer-team effectiveness, and a discussion of the results obtained.

The experimental design shown in Table 7 was successfully completed in June 1964 during 8 days of field activity. A brief description of the two-sided action that occurred during each of the 40 experimental runs is presented in App A. A detailed reconstruction of the sequence of events that occurred during these runs is provided in App B.

TABLE 9

Designation of Experimental Runs

Run	Ground target		Helicopter participation	Antiarmor weapon
	Stationary	Fluid		
1–1 to 1–4	X		Weapons platform	SS-11/UH-1
2–1 to 2–4		X		
3–1 to 3–4	X		Active support	ENTAC
4–1 to 4–4		X		
5–1 to 5–4	X		Passive support	ENTAC
6–1 to 6–4		X		
7–1 to 7–4	X		Active support	90-mm recoilless rifle
8–1 to 8–4		X		
9–1 to 9–4	X		Passive support	90-mm recoilless rifle
10–1 to 10–4		X		

To aid in identifying individual runs in these appendixes and in the analyses that follow, the numbering system shown in Table 9 has been employed. Each experimental run is identified by two numbers. The first number indicates which of the 10 antiarmor-weapon helicopter-participation target-movement combinations the run involved. The second digit indicates which of the four runs for each combination is being considered, e.g., a run involving stationary ground targets in terrain 1 is described by the second digit 1, in terrain 2 by the second

digit 2. For runs with fluid ground vehicles the second digits merely indicate the chronological order in which the runs were conducted.

The overall analysis of the experimental data has been considered from two viewpoints: killer-team attack performance and killer-team "survivability."

In interpreting the results of these analyses the conditions and scope of the antiarmor experiment should be borne in mind. The outcomes observed were influenced by terrain, force structures, simulated fire, and tactical situation.

Terrain

The terrain utilized during the experiment was typical of that found in northern Bavaria; it contained cultivated fields, wooded areas, and rolling hills. These conditions permitted helicopter pilots to employ nap-of-the-earth flight effectively and provided dismounted killer-team personnel with ample concealment. Frequently this terrain also benefited the ground-target vehicles. It delayed their detection, afforded cover to fluid vehicles taken under fire, and diminished the ability of ENTAC crews to obtain line of sight within the effective range of their antiarmor weapon.

Force Structures

The size and composition of the opposing forces must also be considered. The addition of security elements to the dismounted killer crews would probably have enhanced their survivability. On the other hand, the employment of additional infantrymen to protect the stationary and fluid complexes could have reduced the effectiveness of the DKEs. Similarly the presence of aircraft on the ground-vehicle side could have restricted the operation of the helicopter killer teams.

Simulated Fire

The fact that all fire during the experiment was simulated reduced the degree of tactical realism obtained. If the situations had involved live fire, the helicopters and dismounted elements might have been less aggressive in approaching the enemy target complexes and personnel in target complexes under killer-team fire less prompt in responding with return fire. In addition, on those missions in which the antiarmor crew(s) had not been acquired prior to killer-team fire, the correctness of the ground-complex response may have been dependent on the extent to which the simulated antiarmor fire reproduced the visual and audible effects associated with actual fire.

Tactical Situation

The experimental results obtained were also influenced by the nature of the tactical situation studied. Killer-team performance was enhanced by possession of perfect intelligence concerning the location and direction of target-vehicle movement but degraded by the target-complex personnel's suspicion that their positions were known by opposing elements and that enemy attack was imminent.

KILLER-TEAM EFFECTIVENESS

A detailed analysis of killer-team effectiveness in attacking ground-target complexes is presented in App C. The highlights of this analysis are summarized below.

A wide range of outcomes was observed during the 40 experimental runs. On a number of runs the killer elements were able to attack the enemy target complexes and escape without being fired on in return. However, a total of 15 antiarmor missions or three-eighths of those conducted were completely unsuccessful. On these 15 missions, killer elements were unable to acquire enemy target vehicles on 7 occasions, established ambush points after the enemy tanks had passed by on 2 missions, were intercepted or captured by enemy security elements on 4 missions, and fired outside the effective range of their antiarmor weapons on 2 other missions.

On 25 of the 40 runs, killer elements recorded at least one firing at an enemy tank target within the effective range of their antiarmor weapons. On these 25 potentially successful missions, killer-team elements engaged 41 enemy targets, firing a total of 65 wire-guided missiles or 90-mm rounds. Of the 41 targets engaged, 8 were taken under fire by SS-11/UH-1 killer teams, 7 by ENTAC teams with active helicopter support, 7 by ENTAC teams with no helicopter assistance during the attack phase of the killer-team mission, 8 by recoilless-rifle elements with active helicopter support, and 11 by recoilless-rifle crews with passive helicopter support. The killer elements engaged a total of 18 targets in stationary complexes and 23 tank targets in the simulated armor columns.

By combining the firing data recorded during the 25 potentially successful killer-team missions with hit- and kill-probability information,[14–16] estimates of the expected number of enemy vehicles destroyed can be obtained and are given in App C. Summary results indicate that approximately 20 enemy tanks would have been knocked out of action. Of these 20 kills 4 were scored by the SS-11/UH-1 killer teams (which usually consisted of two UH-1 aircraft), 3 by ENTAC teams with active helicopter support, 2 by ENTAC teams with passive helicopter support, 5 by recoilless-rifle teams with active helicopter assistance, and 6 by recoilless-rifle teams with passive helicopters. Of the 20 kills expected 8 were against targets in the stationary complexes and 12 against fluid enemy vehicles.

The estimate of 20 expected kills was based on the assumption that the killer elements were still alive at the times the 65 potentially effective firings against the 41 enemy targets were recorded. In the case of SS-11/UH-1 teams this assumption is questionable, since each SS-11 helicopter had been fired at an average (mean) of six times for an average (mean) of 58 sec before the last potentially effective missile had been launched. The SS-11/UH-1 teams experienced considerable difficulty in acquiring enemy target vehicles; they were unable to detect targets on any of their initial attempts to acquire stationary vehicles, even though the ground-complex vehicles simulated large quantities of fire at the attacking helicopters. On runs involving dismounted ENTAC and recoilless-rifle teams, on the other hand, no firings were recorded against helicopters prior to killer-element dismount on 12 of 19 potentially successful missions and no firings against the dismounted killer elements on 18 of the 19

missions. These results indicate that, if killer-team survival prior to fire is to be considered in the analysis of killer-team performance, the expected number of kills scored by SS-11/UH-1 teams should be discounted considerably more than the expected number of kills scored by the ENTAC or recoilless-rifle elements.

One of the most important findings of the experiment is that helicopter crews experienced difficulty in acquiring targets under the conditions examined. It appears especially significant because the SS-11/UH-1 crews were given the exact map coordinates of stationary target complexes and the location and direction of movement of the simulated tanks in the fluid complexes. Both the pilots and the copilots, employed as SS-11 gunners, were skilled in acquiring target vehicles. However, the natural camouflage used by the stationary vehicle crews (see Fig. 6) successfully broke up the outline of the vehicles and made acquisition at ranges greater than 1000 m very difficult, even with the use of the XM-55 sight. Almost invariably the SS-11/UH-1 crews were unable to detect targets until the stationary complex vehicles disclosed themselves by taking the helicopters under fire. In several cases (see App A) the helicopter crews still could not acquire stationary targets, and launched their missiles at the gunfire-simulator smoke. On runs with fluid target complexes the SS-11/UH-1 crews were able to acquire tank targets on half of their initial passes. None of the antiarmor missions achieved surprise, however; at least one helicopter was taken under fire on each run before an SS-11 missile could be launched at a target vehicle. Difficulties in acquiring enemy ground elements during simulated tactical conditions were also observed during other RAC field experiments involving air-ground interactions.[7–9]

Another major finding is that during the antiarmor missions observed, active helicopter support did not enhance the performance of the DKEs. From information given in App C it is apparent that during the attack phase of the missions dismounted elements with no active support fired at as many targets and as many rounds per target as dismounted elements supported by active helicopters. During the withdrawal phase of the killer-team missions observed, difficulties in coordinating air-ground attacks limited the effectiveness of helicopters in providing timely suppressive fire. It will be seen that on only one potentially successful mission, in which the dismounted elements were supported by active helicopters, was the helicopter crew able to arrive at the scene of action and simulate suppressive fire before the enemy personnel had ceased firing at the withdrawing dismounted elements; at best, helicopter fire would have suppressed a total of only 12 sec of ground fire against the DKEs.

The analyses presented in App C also indicate that the antiarmor teams were noticeably more effective in attacking vehicles with a movement mission than in attacking vehicles in stationary complexes.

GROUND-COMPLEX ACTION AGAINST KILLER TEAMS

Four measures of ground-complex activity against killer teams were studied in detail: (a) number of times killer elements were sighted, (b) number of times killer elements were fired at, (c) number of seconds killer elements were within the view of ground-complex personnel, and (d) number of seconds

TABLE 10

Summary of Ground-Target Action against Helicopters

Experimental run	Phase of killer-team mission	Helicopter			
		Sighted	Fired at	In view	Under fire
		Occurrences		Duration, sec	
1–1	Entry	6	2	91	5
	Attack	30	17	842	249
1–2	Entry	22	7	447	86
	Attack	27	12	501	139
1–3	Entry	27	13	461	61
	Attack	21	14	747	160
1–4	Entry	15	7	308	67
	Attack	8	4	307	53
2–1	Entry	7	1	74	15
	Attack	12	6	215	39
2–2	Entry	6	1	255	12
	Attack	3	3	238	26
2–3	Entry	13	5	393	90
	Attack	2	2	127	58
2–4	Entry	1	0	56	0
	Attack	6	6	175	82
3–1	Entry	1	0	12	0
	Attack	13	10	370	197
3–2	Entry	10	1	166	8
	Attack	22	6	367	55
3–3	Entry	3	0	172	0
	Attack	15	6	597	112
3–4	Entry	2	2	166	13
	Attack	10	8	202	135
4–1	Entry	0	0	0	0
	Attack	6	5	175	35
4–2	Entry	6	1	189	13
	Attack	8	7	458	202
4–3	Entry	3	2	76	7
	Attack	6	0	117	0
4–4	Entry	0	0	0	0
	Attack	2	2	23	14
5–1	Entry	1	0	48	0
	Attack	1	0	4	0
5–2	Entry	9	3	189	35
	Attack	1	1	9	3
5–3	Entry	0	0	0	0
	Attack	1	0	7	0
5–4	Entry	15	10	263	75
	Attack	1	1	94	19

TABLE 10--Continued

Experimental run	Phase of killer-team mission	Helicopter			
		Sighted	Fired at	In view	Under fire
		Occurrences		Duration, sec	
6–1	Entry	2	0	26	0
	Attack	0	0	0	0
6–2	Entry	0	0	0	0
	Attack	0	0	0	0
6–3	Entry	0	0	0	0
	Attack	2	0	26	0
6–4	Entry	5	3	126	15
	Attack	11	10	1810	333
7–1	Entry	5	4	131	80
	Attack	12	9	364	110
7–2	Entry	4	1	66	12
	Attack	6	5	135	52
7–3	Entry	1	0	155	0
	Attack	6	2	151	11
7–4	Entry	2	0	81	0
	Attack	11	5	308	86
8–1	Entry	0	0	0	0
	Attack	0	0	0	0
8–2	Entry	0	0	0	0
	Attack	5	4	81	26
8–3	Entry	0	0	0	0
	Attack	7	3	293	40
8–4	Entry	0	0	0	0
	Attack	2	1	55	7
9–1	Entry	13	5	204	23
	Attack	1	0	4	0
9–2	Entry	4	0	234	0
	Attack	1	0	3	0
9–3	Entry	7	1	81	12
	Attack	1	0	5	0
9–4	Entry	2	0	34	0
	Attack	1	0	6	0
10–1	Entry	0	0	0	0
	Attack	0	0	0	0
10–2	Entry	0	0	0	0
	Attack	0	0	0	0
10–3	Entry	0	0	0	0
	Attack	0	0	0	0
10–4	Entry	1	0	8	0
	Attack	1	1	28	7

killer elements were under ground-complex fire. The basic experimental data for each of these measures are summarized in Tables 10 and 11. These data have been used in the statistical analyses of ground-complex action against killer-team elements presented in App D.

TABLE 11

Summary of Ground-Target Action against Dismounted Killer Elements

Experimental run	Dismounted killer team			
	Sighted	Fired at	In view	Under fire
	Occurrences		Duration, sec	
3–1	1	1	45	10
3–2	0	0	0	0
3–3	3	1	102	4
3–4	1	1	30	20
4–1	1	0	10	0
4–2	2	2	55	31
4–3	1	0	10	0
4–4	1	1	13	6
5–1	1	1	132	2
5–2	1	1	21	10
5–3	0	0	0	0
5–4	0	0	0	0
6–1	0	0	0	0
6–2	3	1	30	6
6–3	0	0	0	0
6–4	2	2	72	20
7–1	3	1	29	7
7–2	2	1	21	2
7–3	2	2	61	30
7–4	0	0	0	0
8–1	3	3	74	18
8–2	0	0	0	0
8–3	5	3	169	29
8–4	3	3	101	14
9–1	1	0	6	0
9–2	3	1	24	1
9–3	1	1	7	6
9–4	5	1	31	5
10–1	3	3	52	21
10–2	3	2	95	24
10–3	2	2	86	23
10–4	1	0	11	0

Appendix D analyses of helicopter elusiveness during the entry and attack phases of the killer-team mission indicate that (a) significantly fewer helicopters were seen and fired at by fluid enemy vehicles during helicopter entry into the mission area than by vehicles in stationary complexes, and (b) during the attack phase of the killer-team mission, some types of killer-team helicopters drew

noticeably more fire than others; e.g., ground action against the SS-11 aircraft and helicopters supporting dismounted ENTAC elements was particularly heavy.

Analyses limited to data for runs with DKEs revealed that (a) based on the number of times helicopters were acquired and taken under fire, the amount of enemy activity against passive helicopters was significantly less than against helicopters that provided active support, and (b) vehicles in stationary enemy complexes acquired significantly more helicopters than vehicles in fluid complexes.

In addition, analyses based on the evasiveness of DKEs indicated that noticeably more acquisitions and firings were recorded against recoilless-rifle crews than against ENTAC teams.

The experimental results summarized in this chapter indicate that the antiarmor teams observed during the RAC field experiment did not achieve the degree of success attained by tank-killer teams during FTX YELLOW WEDGE. Direct comparisons of data from the two field ventures are tenuous at best. It may be useful, however, to point out several fundamental differences between YELLOW WEDGE and the RAC test that could lead to a variation in the outcomes observed. These include

(a) Differences in the targets engaged. All the targets engaged by killer elements during FTX YELLOW WEDGE were fluid ones; no missions were flown against stationary targets in well-concealed positions. In YELLOW WEDGE, moreover, the enemy elements attacked were frequently targets of opportunity; during the RAC experiment, on the other hand, all missions were flown against designated target complexes.

(b) Differences in enemy personnel. The ground personnel during the RAC experiment suspected that their vehicles were being employed as targets and consequently were continually expecting to be attacked by enemy elements; they always had the benefit of friendly security forces. In addition, the RAC target-complex personnel were never faced with the problem of how to respond to helicopter sightings as were the YELLOW WEDGE personnel. These differences help to account for the difficulties in achieving surprise that were encountered by antiarmor teams during the RAC experiment.

(c) Differences in evaluation procedures. The fact that the YELLOW WEDGE missions were evaluated by umpires and the RAC missions on the basis of information collected by data-recording instruments could lead to differences in the assessment of mission success.

Appendix A

SYNOPSIS OF ACTION DURING EXPERIMENTAL RUNS

General

This appendix presents a brief qualitative description of the two-sided action that occurred during each experimental run. The synopses presented were compiled from five data sources: (a) event-sequence recorders, (b) gun-camera film, (c) miniature tape recorders, (d) information recorded by RAC analysts during each run, and (e) debriefings of killer-team and ground-complex personnel at the conclusion of each run.

On the first six experimental runs described, two UH-1B aircraft were employed on each run. The employment of two helicopters is consistent with the current practice of using pairs of aircraft on tactical missions of the type studied. Because of other training commitments, however, only one UH-1B was available for runs 2-3 and 2-4.

During the experimental runs with stationary target vehicles the killer teams were given the location of the target complex. The killer elements were instructed to destroy all vehicles acquired in this complex. In the descriptions that follow the target complex is referred to as the A complex. The killer teams were not given the coordinates of the secondary targets in the B complex but they were informed that unreported enemy elements might be present within the mission area.

Although it would have been desirable to terminate each run as the killer elements were leaving the mission area, it was necessary to call administrative ends to several runs. During these runs one of the following situations was encountered: (a) the killer team became completely lost, (b) the killer team was unable to obtain line of sight to the target vehicles, or (c) the killer team was physically captured or fired on at point-blank range.

SS-11/UH-1, Stationary Targets

Run 1-1. The two helicopters experienced difficulty in acquiring enemy ground targets. The target complexes were alerted to the general location of the aircraft by engine noise. Both helicopters sustained heavy fire. The lead aircraft launched its first missile 1500 m from the target complex without having acquired a specific target but having seen only gunfire-simulator smoke. On this helicopter's second pass, a target was acquired and fired on from approximately 2000 m. The second helicopter did not acquire a target on the first pass and was unable to fire on a second pass because the lead aircraft turned in front of the second as the second helicopter was preparing to fire.

Run 1-2. The helicopters were repeatedly acquired and taken under fire before any ground elements were acquired. The first aircraft fired at a vehicle in the secondary, B, complex at 1200-m range and then veered and launched another missile at a target in the A complex at a range of 900 m. The second helicopter also fired his first missile at a B-complex vehicle. After regrouping, the two helicopters made another pass. One fired at the B complex and the

other at the designated target complex at ranges of 2000 and 1300 m, respectively. Both aircraft sustained heavy ground fire.

Run 1-3. The helicopters were seen and fired on repeatedly before they launched their missiles. The first helicopter could not sight a target and in attempting to employ reconnaissance by fire the pilot launched two missiles toward the B-complex woodline at ranges of 1500 and 1000 m. The second aircraft sighted targets in the A complex from gunfire-simulator smoke and fired twice at target vehicles at ranges of 1000 and 2400 m. The second helicopter's attack, however, lacked surprise and the aircraft sustained heavy ground fire.

Run 1-4. The aircraft were unable to identify specific targets. After the first helicopter made a pass to draw fire, the second aircraft launched a missile toward the ensuing gunfire-simulator smoke. Both fired from less than 800 m and both sustained considerable ground fire.

SS-11/UH-1, Fluid Targets

Run 2-1. The first aircraft attacked the lead vehicle of the armor column. The firing pass was made across an open field 1500 m from the target. The second helicopter was unable to acquire a target until the aircraft had come within a range of 300 m.

Run 2-2. While leaving a small town the armor column observed the two helicopters at far range. The helicopters erroneously took the security vehicles for their prime targets and attacked them. One aircraft made a second pass and fired at a scout vehicle at a range of 2000 m.

Run 2-3. The helicopter was able to locate the column with no difficulty but was repeatedly fired on prior to acquiring it. One of the ground vehicles was able to fire at the aircraft for approximately one full minute. The aircraft launched a missile at the lead armored vehicle at a range of 1500 m. The attack lacked the element of surprise.

Run 2-4. One of the security elements observed the helicopter and alerted the column. The helicopter launched a missile from 2000 m and closed on the column rapidly, sustaining fire from three ground elements.

ENTAC, Active Helicopter, Stationary Targets

Run 3-1. The aircraft was initially detected at 3000-m range by a vehicle in the A complex. Infantry from the A complex were dispatched to investigate the suspected helicopter landing area. After dismounting the ENTAC crew the aircraft fired at the A complex on three occasions to assist the ENTAC crew in acquiring target vehicles. The ENTAC crew, however, was unable to acquire a target and returned to the pickup point. When the helicopter landed to retrieve the dismounted ground elements, the infantry from the A complex attacked the landed aircraft and ENTAC personnel, firing many simulated rounds at close range.

Run 3-2. Prior to dismounting the ENTAC team the helicopter was frequently sighted. During their attack the dismounted ground elements were unable to find an advantageous firing position that offered line of sight to any target vehicles. When the helicopter attempted to direct the ENTAC crew to satisfactory firing positions, the aircraft was fired on by the B complex. During the run neither the aircraft nor the ENTAC crew engaged any enemy targets.

Run 3-3. The aircraft was sighted early in the run by both target complexes at ranges in excess of 4000 m. The ENTAC crew was dismounted behind a woodline about 1300 m from the target. The dismounted elements acquired one target and fired two missiles, drawing immediate return fire. The helicopter provided simulated 2.75-in. rocket fire during the withdrawal of the ENTAC crew. Approximately 5 min after furnishing suppressive fire the helicopter picked up the ENTAC crew. After accomplishing the rendezvous operation the helicopter was fired on three times by enemy elements.

Run 3-4. While the ENTAC personnel were departing from the helicopter, the B complex reported the landing of an aircraft and both complexes dispatched infantry to the suspected position of the ENTAC team. The helicopter attempted to provide diversionary fire and received return fire from both complexes. As the ENTAC crew was setting up their weapons system they were surrounded and fired on at point-blank range by infantry from both ground-target complexes.

ENTAC, Active Helicopter, Fluid Targets

Run 4-1. The ENTAC crew dismounted from the helicopter without being detected and set up an ambush position 800 m from the column's line of march. The ENTAC team fired twice at the lead element in the column. Two minutes later the helicopter made a firing pass in an attempt to provide suppressive fire to cover the escape of the ENTAC crew. By this time, however, the security vehicles had regrouped around the column and the aircraft was fired on by four different enemy elements. The dismounted ground elements were recovered without further incident.

Run 4-2. The aircraft made several diversionary landings prior to dismounting the ENTAC personnel. On one of these landings the helicopter was detected by both the security elements and the vehicles in the column. After discharging the ENTAC team, the aircraft received heavy ground fire while en route to a holding area. The ENTAC crew established a firing position approximately 500 m from the target vehicles. Two ENTAC missiles were fired at the lead element in the column from this range. The helicopter attacked the column approximately 1 min later, but by this time the ENTAC crew had withdrawn from their ambush position.

Run 4-3. The helicopter was observed and fired on twice while making several diversionary landings prior to dismounting the team. On this run the false landings decoyed the security elements to wrong locations. The ENTAC crew engaged both armor column vehicles at a range of 1400 m without drawing return fire. The helicopter's diversionary-fire pass also achieved complete surprise. The ENTAC crew was recovered without further incident.

Run 4-4. The ENTAC crew waited in ambush for 10 min before the column's security elements were detected. The ambush position was 1500 m from the route of march and provided excellent concealment. Both column vehicles were taken under fire. The helicopter took the column under fire 40 sec later. During the run the dismounted ground elements were fired at once and the helicopter twice.

ENTAC, Passive Helicopter, Stationary Targets

Run 5-1. The ENTAC team dismounted behind a woodline 800 m from the designated targets. Although the A complex heard the helicopter land, its infantry

were unable to get to the area of suspected killer-team activity in time. The ENTAC crew fired at the two A-complex vehicles at 550-m range. Neither the helicopter nor the dismounted ground elements were fired on during the pick-up phase of the killer-team mission.

Run 5-2. The helicopter was sighted by both target complexes and taken under fire by the B complex prior to dismounting the ENTAC crew. Infantry from the two target complexes were dispatched to clear an area of suspected enemy activity. The ENTAC crew fired one missile from a hastily prepared position at less than the weapon's minimum range. Before the ENTAC crew could withdraw they were surprised and overrun by the infantry from the A complex.

Run 5-3. The ENTAC team was dismounted approximately 2½ km from their stationary ground targets. The dismounted ground elements became lost in their attempt to acquire the enemy vehicles and were retrieved by the helicopter 1 hr and 20 min later.

Run 5-4. While the pilot was locating an advantageous landing area, the helicopter was sighted and fired on by both complexes at ranges from 700 to 1300 m. After landing the ENTAC crew the pilot withdrew to a holding area. The ENTAC crew fired at the two A-complex vehicles from 1000 m and made an undetected escape.

ENTAC, Passive Helicopter, Fluid Targets

Run 6-1. The helicopter was sighted by the column early in the run at a range that exceeded 3000 m. The ENTAC team was dismounted undetected, but was unable to complete the setup of their weapons system before the column passed by their vantage point. The helicopter recovered the team without incident.

Run 6-2. The heliborne ENTAC crew was deployed successfully in a woodline 800 m from the expected line of march of the armor column. After avoiding the security elements that came near the ambush position, the ENTAC crew fired at both column vehicles. During the ENTAC team's withdrawal, both column elements acquired the DKEs and one enemy vehicle took them under fire.

Run 6-3. The dismounted ENTAC crew established a firing position near the edge of a woods 1000 m from the column's expected route of march. When the reconnaissance vehicles providing security for the column approached the ambush position the ENTAC crew withdrew into the woods to avoid detection. Before the crew was able to rewire the ENTAC system the column had passed by the firing position. The ENTAC crew was recovered without further incident.

Run 6-4. Elements of the security forces and the armored column acquired and fired at the aircraft prior to ENTAC team dismount. After delivering the ENTAC crew the pilot landed the helicopter behind a wooded knoll 800 m from the expected enemy route of advance instead of assuming a passive role and withdrawing to friendly territory. One of the scout vehicles observed the aircraft's rotor above the masking vegetation. After this reconnaissance vehicle had alerted the other scouts and the column vehicles, all five ground elements took the helicopter under sustained fire. The ENTAC squad fired a missile at the head of the column from 700-m range but was quickly overrun and cut off from retreat.

Recoilless Rifle, Active Helicopter, Stationary Targets

Run 7-1. While attempting to dismount the recoilless-rifle teams the helicopter landed less than 400 m from the B complex and sustained heavy ground fire. After a rapid lift-off the pilot selected a new dismount point and made an undetected landing. The DKEs requested that the helicopter simulate rocket fire at the target complex in order to draw return fire. When the ground complex took the helicopter under fire the DKEs acquired targets in the A complex. After creeping to within 30 m of the target vehicles the recoilless-rifle elements fired 2 rds at each target. During the recovery portion of the killer-team mission, both the helicopter and the dismounted ground elements were taken under fire.

Run 7-2. The aircraft was sighted four times and fired at once prior to landing the heliborne infantry. Both armored vehicles in the target complex reported sighting enemy ground elements but lost contact prior to firing at them. The DKEs then fired 2 rds at each target from a position 200 m to the target's rear. The helicopter pilot supported his dismounted teammates by simulating 2.75-in. rocket fire on the A complex but in doing so directly exposed himself to the B complex, whose vehicles were able to fire one long burst at close range.

Run 7-3. The helicopter was sighted when it landed too close to the target complex. Infantry of A complex ran to the landing zone and opened fire on the helicopter and dismounted infantry as the aircraft was lifting off and as the recoilless-rifle personnel were running for cover. The DKEs were captured by additional infantry dispatched from the ground complexes.

Run 7-4. Infantry from the A complex sighted the helicopter when it landed to deliver the recoilless-rifle crews and investigated the suspected landing area but made no contact with the killer elements. While attempting to assist the recoilless-rifle personnel in acquiring target vehicles the aircraft was sighted and fired at by the B complex at ranges of 600 to 800 m. After an hour the recoilless-rifle team still had not acquired any target vehicles. Just prior to recovering the dismounted elements the helicopter fired at the target complex and drew heavy return fire.

Recoilless Rifle, Active Helicopter, Fluid Targets

Run 8-1. The killer elements were dismounted unobserved. While conducting their security mission the lead scout vehicles made contact with the recoilless-rifle crews, drew their fire, and prevented their escape. Because the attention of the ground vehicles was focused on the DKEs the helicopter was able to make a firing pass without encountering return fire.

Run 8-2. The recoilless-rifle team was dismounted without being observed; they became disoriented, however, and set up an ambush position along the wrong road. Radio communications problems between the dismounted elements and the aircraft prevented the coordination of air-ground killer activites. The helicopter surprised the column with a close-range strafing pass but was fired on by several enemy vehicles. The dismounted recoilless-rifle personnel were later recovered without incident.

Run 8-3. After dismounting undetected the recoilless-rifle crews ambushed the column at ranges of 150 and 200 m. While attempting to withdraw to a prearranged pickup point the DKEs were acquired and taken under fire.

The group of trees in which they had been hiding was surrounded by enemy scout vehicles. After several attempts to elude the enemy elements the recoilless-rifle team was cornered and fired on at point-blank range.

Run 8-4. The recoilless-rifle crews reached their destination unobserved. They took both armored elements in the column under fire at a range of 200 m. The helicopter pilot provided suppressive fire but not until after the column vehicles had returned the recoilless-rifle fire. During the withdrawal of the DKEs they were acquired and taken under fire at 50-m range by one of the enemy reconnaissance vehicles.

Recoilless Rifle, Passive Helicopter, Stationary Targets

Run 9-1. The helicopter was fired at five times prior to dismounting the recoilless-rifle crews. The DKEs acquired the two vehicles in the A complex and took them under fire at 350-m range. Although the recoilless-rifle team was observed briefly, they were not fired on and were recovered by the helicopter unobserved.

Run 9-2. The target complex was alerted to the presence of enemy activity early in the run when the aircraft exposed itself briefly while on the way toward a preselected landing site. The helicopter was heard setting down behind a woodline, and infantry were dispatched to intercept the attacking elements. The dismounted recoilless-rifle team avoided the opposing infantry and each crew fired 2 rds at A-complex vehicles positioned 200 and 400 m from the killer elements. While withdrawing, the recoilless-rifle team was briefly sighted and fired at by elements of the target complex.

Run 9-3. The helicopter was seen by both ground complexes during the entry phase of the killer-team mission. As the aircraft was landing to dismount its heliborne infantry, it was acquired audibly by elements in the A complex. Infantry dispatched from this complex surprised one of the approaching recoilless-rifle crews and captured them. Additional infantry elements from the ground complex pursued the other half of the recoilless-rifle team beyond the effective range of the 90-mm weapon.

Run 9-4. The helicopter was sighted by members of the A complex as it disappeared behind a woodline approximately 1000 m from the ground complex. As infantry from the A complex approached them, the DKEs fired at the ground-target vehicles at ranges that exceeded the effective range of their 90-mm weapons. The ground-complex infantry encircled the recoilless-rifle crews and fired at them at less than 50-m range.

Recoilless Rifle, Passive Helicopter, Fluid Targets

Run 10-1. The heliborne killer elements dismounted and established an ambush position without being detected. Each recoilless-rifle crew fired 2 rds at preselected column targets at 200-m range, drawing return fire from both armor vehicles in the column. One ground security vehicle attempted to cut off the DKEs' withdrawal and was ambushed by the recoilless-rifle team at 30-m range.

Run 10-2. The helicopter delivered the ground portion of the killer team without incident. Security elements of the approaching column observed one of the recoilless-rifle squads crossing a road and maneuvered to attack. Shortly

after one of the scout vehicles fired at the heliborne infantry observed, the undetected recoilless-rifle crew fired at the lead element of the armor column at 150-m range.

Run 10-3. The helicopter delivered the DKEs to a wooded position 250 m from a suitable ambush site. The security elements passed by without making contact with the killer teams. Each recoilless-rifle crew fired 2 rds at the column vehicles from ranges of 30 and 80 m. The killer elements were acquired by the vehicles in the column and fired on as they retreated. No acquisitions of the helicopter were recorded during the killer-team mission.

Run 10-4. The aircraft pilot landed his teammates about 200 m from the expected route of enemy advance. At 100-m range the recoilless-rifle team fired a total of 4 rds at the two column vehicles and then withdrew without being fired on in return. After picking up the DKEs the helicopter was taken under fire by one of the column's security vehicles.

Appendix B

RECONSTRUCTION OF EVENTS DURING EXPERIMENTAL RUNS

Tables

This appendix presents a reconstruction of the sequence of events that occurred during the 40 antiarmor-experiment runs. The basic data shown in the appendix tables were obtained from the event-sequence recorders and the stopwatches carried by elements on each side. The elapsed times shown in each table represent the number of minutes and seconds that passed after each killer team departed from the staging area at Schwabach.

TABLE B1

Reconstruction of Events in Run 1-1

(SS-11/UH-1, stationary targets)

Symbol	Event	Elapsed time, min:sec	Symbol	Event	Elapsed time, min:sec
1	A2 acquires H	6:40	27	B1 acquires H	15:28
2	A3 acquires H	7:27	28	B2 acquires H	15:31
3	A2 acquires H	7:28	29	B3 acquires H	15:32
4	A3 fires at H	7:29	30	H1 begins firing pass	16:41
5	B1 acquires H	8:28	31	A3 acquires H	16:49
6	B2 acquires H	8:34	32	H1 fires at A	17:00
7	B2 fires at H	8:39	33	A1 acquires H1, H2	17:31
8	B1 acquires H	9:42	34	A3 acquires H	18:01
			35	A2 acquires H	18:24
9	H1 begins firing pass	10:29	36	A1 fires at H1, H2	18:32
10	A3 acquires H	10:35	37	B3 acquires H	18:51
11	A2 acquires H	10:39	38	B1 acquires H	18:52
12	A3 fires at H	10:39	39	B2 acquires H	18:52
13	H1 fires at A	10:40	40	B1 fires at H	18:53
14	A2 fires at H	10:44	41	B3 fires at H	18:57
15	B3 acquires H1, H2	10:50	42	B2 fires at H	18:59
15	A1 acquires H	10:54	43	A2 acquires H	19:19
17	B1 acquires H	10:56	44	A1 acquires H	19:22
18	B2 acquires H1, H2	10:57	45	B3 acquires H	19:25
19	B1 fires at H	11:01	46	B1 acquires H	19:27
20	B2 fires at H1, H2	11:07	47	B1 fires at H	19:28
21	B3 fires at H1, H2	11:08	48	A3 acquires H	19:36
22	B1 acquires H	11:30	49	A3 fires at H	19:40
23	B1 fires at H	11:31	50	A2 acquires H	19:44
24	A2 acquires H	11:55	51	A2 acquires H	20:28
25	B2 acquires H	12:09	52	A2 acquires H	22:36
26	B2 fires at H	12:19	53	A2 fires at H	22:37

In Tables B1–B40 the following nomenclature is used to identify individual elements: H for one helicopter; H1 and H2 for two helicopters; DKE for dismounted killer elements of the killer team; A1 and A2 for stationary vehicles in the A complex; A3 for infantry attached to the A complex; B1 and B2 for

TABLE B2

Reconstruction of Events in Run 1-2

(SS-11/UH-1, stationary targets)

Symbol	Event	Elapsed time, min:sec	Symbol	Event	Elapsed time, min:sec
1	B3 acquires H	14:40	35	H1 fires at A	35:09
2	B2 acquires H	14:40	36	B2 acquires H	35:19
3	A3 acquires H	17:06	37	H2 fires at B	35:26
4	A3 acquires H	19:37	38	B2 fires at H	35:32
5	B3 acquires H	20:30	39	A3 acquires H	35:33
6	B2 acquires H	22:15	40	A2 acquires H	35:46
7	B2 fires at H	22:24	41	B1 acquires H	35:52
8	B3 acquires H	22:26	42	B3 acquires H	35:57
9	B2 acquires H	23:59	43	B1 fires at H	35:57
10	B2 fires at H	24:02	44	A2 acquires H	36:05
11	A3 acquires H	25:19	45	A3 acquires H	36:06
12	B1 acquires H	25:20	46	A3 fires at H	36:16
13	B1 fires at H	25:21	47	A1 acquires H	36:20
14	B3 acquires H	25:36	48	A2 acquires H	36:30
15	B2 acquires H	25:46	49	B3 fires at H	36:32
16	B1 acquires H	25:47	50	A3 acquires H	36:34
17	B3 acquires H	25:50	51	A3 fires at H	36:37
18	B2 fires at H	26:36	52	B3 acquires H	36:52
19	A3 acquires H	26:57	53	B3 fires at H	36:54
20	B1 acquires H	27:07	54	H1, H2 begin firing runs	38:53
21	B1 fires at H	27:08	55	H1 fires at A	39:01
22	B2 acquires H	27:09	56	H2 fires at B	39:04
23	A2 acquires H	27:11	57	A2 acquires H	39:14
24	B2 fires at H	27:12	58	A2 acquires H	39:26
25	B3 acquires H	27:36	59	A2 acquires H1, H2	39:53
26	B2 acquires H	27:43	60	A3 acquires H1, H2	40:04
27	B3 acquires H	27:43	61	B1 acquires H1, H2	40:13
28	B2 fires at H	27:46	62	B3 acquires H1, H2	40:13
29	A3 acquires H	32:34	63	B2 acquires H1, H2	40:16
			64	B2 fires at H	40:18
30	H1 begins firing pass	34:02	65	A3 fires at H	40:28
31	B2 acquires H	34:12	66	A1 acquires H	40:31
32	B2 fires at H	34:17	67	B3 fires at H1, H2	40:35
33	H1 fires at B	34:31	68	B2 acquires H	41:36
34	A2 acquires H	34:55	69	B2 fires at H	41:37

stationary vehicles in the B complex; B3 for infantry attached to the B complex; C1 and C2 for elements in the armor column; and S1, S2, and S3 for the scout vehicles providing route security for the column.

For analytical purposes the runs have been divided into three phases: (a) killer-team entry, (b) killer-team attack, and (c) killer-team withdrawal. On runs involving DKEs the attack phase of the mission is considered to begin with heliborne infantry dismount and the withdrawal phase with the pickup of the dismounted elements. On runs involving the SS-11/UH-1 weapons system the distinction between the three phases is less clear; for convenience the attack phase is assumed to begin when the lead helicopter begins his firing pass and the withdrawal phase, when the lead helicopter is about to leave the mission area.

TABLE B3

Reconstruction of Events in Run 1-3

(SS-11/UH-1, stationary targets)

Symbol	Event	Elapsed time, min:sec	Symbol	Event	Elapsed time, min:sec
1	A2 acquires H	6:16	41	H1 begins firing pass	19:01
2	A3 acquires H	7:38	42	H1 fires at B	19:20
3	A1 acquires H	7:54	43	B1 acquires H	19:29
4	A1 fires at H	8:12	44	B3 acquires H	19:30
5	A3 acquires H	8:43	45	B2 acquires H	19:30
6	B1 acquires H	10:12	46	H1 fires at B	19:31
7	B2 acquires H	10:13	47	A2 acquires H	19:32
8	B3 acquires H	10:16	48	B2 fires at H	19:36
9	B2 fires at H	10:17	49	A1 acquires H	19:36
10	B1 fires at H	10:18	50	A1 fires at H	19:42
11	B2 acquires H	10:38	51	A2 fires at H	19:52
12	B1 acquires H	10:39	52	B2 acquires H	20:12
13	B2 fires at H	10:40	53	B2 fires at H	20:13
14	B1 fires at H	10:40	54	B1 acquires H	20:14
15	A2 acquires H	11:56	55	A2 acquires H	20:20
16	A2 fires at H	12:04	56	B3 acquires H	20:23
17	A2 acquires H	12:51	57	A2 fires at H	20:25
18	A2 fires at H	12:56	58	A3 acquires H	20:30
19	A3 acquires H	12:57	59	H2 begins firing pass	21:17
20	A1 acquires H	13:03	60	H2 fires at A	21:28
21	A2 acquires H	13:32	61	A3 acquires H	21:32
22	A1 acquires H	13:37	62	A2 acquires H	21:35
23	A2 fires at H	13:47	63	A2 fires at H	21:43
24	B3 acquires H	13:56	64	A3 fires at H	21:44
25	B2 acquires H	13:57	65	A1 acquires H	21:46
26	B3 fires at H	13:59	66	A1 fires at H	21:50
27	B2 acquires H	14:41	67	B3 acquires H	21:56
28	B1 acquires H	14:42	68	B2 acquires H	21:56
29	B1 fires at H	14:44	69	B1 acquires H	21:57
30	A2 acquires H	14:46	70	B1 fires at H	21:58
31	B1 acquires H	14:54	71	B2 fires at H	22:01
32	B1 fires at H	14:54	72	H2 begins firing pass	22:12
33	B2 acquires H	14:54	73	H2 fires at A	22:20
34	B2 acquires H	15:41	74	A1 acquires H	22:28
35	B1 acquires H	15:42	75	A3 acquires H	22:47
36	B3 acquires H	15:52	76	B3 acquires H	22:54
37	B2 fires at H	15:54	77	B2 acquires H	23:00
38	A2 acquires H	16:09	78	B2 fires at H	23:04
39	A3 acquires H	16:10	79	A1 fires at H	23:06
40	A2 fires at H	16:12	80	A3 fires at H	23:10
			81	A2 acquires H	23:13
			82	A2 fires at H	23:44

TABLE B4

Reconstruction of Events in Run 1-4

(SS-11/UH-1, stationary targets)

Symbol	Event	Elapsed time, min:sec	Symbol	Event	Elapsed time, min:sec
1	A1 acquires H	6:01	21	H1 begins firing pass	14:39
2	B2 acquires H	6:16	22	H1 fires at B	14:45
3	B2 fires at H	6:18	23	B1 acquires H	14:48
4	B3 acquires H1, H2	6:22	24	B1 fires at H	14:48
5	A2 acquires H	6:33	25	B2 acquires H	14:54
6	A3 acquires H1, H2	6:41	26	B3 acquires H	15:04
7	A2 fires at H	6:41	27	B2 fires at H	15:04
8	B1 acquires H	6:44	28	A3 acquires H	15:07
9	B1 fires at H	7:00	29	A2 acquires H	15:09
10	B3 acquires H	7:00	30	A1 acquires H	15:10
11	B3 fires at H	7:14	31	A1 fires at H	15:10
12	A1 acquires H	9:39	32	H2 begins firing pass	15:10
13	A3 acquires H	9:39	33	H2 fires at B	15:18
14	A3 fires at H	9:53	34	A3 fires at H	15:19
15	A2 acquires H	10:05	35	B3 acquires H	16:20
16	A3 acquires H	11:51	36	B2 acquires H	16:22
17	B1 acquires H	13:58			
18	B1 fires at H	14:02			
19	B1 acquires H	14:34			
20	B1 fires at H	14:34			

TABLE B5

Reconstruction of Events in Run 2-1

(SS-11/UH-1, fluid targets)

Symbol	Event	Elapsed time, min:sec	Symbol	Event	Elapsed time, min:sec
1	C1 acquires H	7:49	15	S1 acquires H	10:35
2	C2 acquires H	7:55	16	H2 begins firing pass	11:20
3	C1 acquires H1, H2	8:12	17	H2 fires at C	11:32
4	C1 fires at H	8:17	18	C1 acquires H	11:33
5	S1 acquires H	8:23	19	C2 acquires H	11:35
6	C1 acquires H	9:07	20	C2 fires at H	11:40
7	C1 acquires H	9:51	21	C1 fires at H	11:41
			22	S3 acquires H	11:43
8	H1 begins firing pass	9:55	23	S1 acquires H	11:50
9	H1 fires at C	9:57	24	C1 acquires H	11:53
10	C1 fires at H	10:06	25	C2 acquires H	11:54
11	S2 acquires H	10:09	26	S3 fires at H	11:56
12	C2 acquires H	10:14	27	C1 acquires H	12:31
13	S2 fires at H	10:17	28	C1 acquires H1, H2	12:55
14	C2 fires at H	10:22			

TABLE B6

Reconstruction of Events in Run 2-2

(SS-11/UH-1, fluid targets)

Symbol	Event	Elapsed time, min:sec	Symbol	Event	Elapsed time, min:sec
1	C2 acquires H	9:34	9	C1 fires at H	13:30
2	C1 acquires H1, H2	9:46	10	C1 fires at H	13:34
3	S3 acquires H	12:28	11	S3 acquires H	14:12
4	S1 acquires H	12:38	12	H2 begins firing pass	14:17
5	S3 fires at H	12:44	13	H2 fires at S	14:24
6	S1 acquires H	12:58	14	S3 fires at H	14:31
			15	S1 acquires H	14:44
7	H1, H2 begin firing pass	13:01	16	C2 acquires H	14:46
8	H1, H2 fire at S	13:06			

TABLE B7

Reconstruction of Events in Run 2-3

(SS-11/UH-1, fluid targets)

Symbol	Event	Elapsed time, min:sec	Symbol	Event	Elapsed time, min:sec
1	C1 acquires H	19:59	14	C2 fires at H	34:42
2	S3 acquires H	20:00	15	C1 fires at H	34:43
3	S3 acquires H	23:52	16	S2 fires at H	34:43
4	C1 acquires H	24:32	17	S1 acquires H	34:48
5	C1 acquires H	28:26	18	S1 fires at H	34:52
6	S2 acquires H	28:48			
7	C2 acquires H	28:58	19	H begins firing pass	34:55
8	S1 acquires H	29:14	20	H fires at C	35:00
9	C1 acquires H	29:16	21	C2 acquires H	35:08
10	C1 fires at H	29:38	22	S1 acquires H	35:09
11	S2 acquires H	34:31	23	C2 fires at H	35:10
12	C2 acquires H	34:34	24	S1 fires at H	35:14
13	C1 acquires H	34:39			

TABLE B8

Reconstruction of Events in Run 2-4

(SS-11/UH-1, fluid targets)

Symbol	Event	Elapsed time, min:sec	Symbol	Event	Elapsed time, min:sec
1	S2 acquires H	11:24	8	C1 fires at H	12:37
			9	C2 fires at H	12:38
2	H begins firing pass	12:25	10	S3 acquires H	12:39
			11	S3 fires at H	12:42
3	S2 acquires H	12:26	12	C2 acquires H	13:39
4	C2 acquires H	12:28	13	C2 fires at H	13:41
5	S2 fires at H	12:29	14	C1 acquires H	13:43
6	H fires at C	12:30	15	C1 fires at H	13:47
7	C1 acquires H	12:33			

TABLE B9

Reconstruction of Events in Run 3-1

(ENTAC, active helicopter, stationary targets)

Symbol	Event	Elapsed time, min:sec	Symbol	Event	Elapsed time, min:sec
1	A1 acquires H	20:38	15	A3 acquires H	45:13
2	H dismounts DKE	23:55	16	A2 acquires H	45:46
			17	A2 fires at H	45:53
3	A1 acquires H	24:41	18	H fires at A	46:00
4	A1 fires at H	24:41	19	A3 acquires H	46:01
5	A1 acquires H	26:15	20	A1 acquires H	46:07
6	A2 acquires H	32:44	21	A1 fires at H	46:07
7	A2 fires at H	32:58	22	H fires at A	46:33
8	H fires at A	33:28	23	A1 acquires H	47:20
9	A1 acquires H	33:40	24	A1 fires at H	47:22
10	A1 fires at H	33:40	25	A1 acquires H	47:47
11	A1 acquires H	45:00	26	A1 fires at H	47:47
12	A1 fires at H	45:01	27	A3 acquires H, DKE	48:35
13	A2 acquires H	45:04	28	A3 fires at H, DKE	48:50
14	A2 fires at H	45:08			

TABLE B10

Reconstruction of Events in Run 3-2

(ENTAC, active helicopter, stationary targets)

Symbol	Event	Elapsed time, min:sec	Symbol	Event	Elapsed time, min:sec
1	B2 acquires H	21:48	22	B1 fires at H	44:12
2	B2 acquires H	22:03	23	B3 acquires H	44:22
3	B2 acquires H	22:17	24	A3 acquires H	44:31
4	B2 fires at H	22:19	25	A2 acquires H	44:31
5	A3 acquires H	22:23	26	B3 acquires H	47:41
6	B3 acquires H	22:29	27	B2 acquires H	48:13
7	B2 acquires H	23:58	28	B3 fires at H	48:17
8	B3 acquires H	23:59	29	B1 acquires H	48:18
9	B2 acquires H	24:22	30	B1 fires at H	48:37
10	B3 acquires H	24:22	31	A3 acquires H	48:45
11	B2 acquires H	25:26	32	B3 acquires H	53:07
12	H dismounts DKE	25:52	33	B3 acquires H	53:16
			34	B2 acquires H	53:16
13	B2 acquires H	27:04	35	A1 acquires H	53:18
14	B3 acquires H	27:19	36	B2 fires at H	53:22
15	B2 fires at H	27:30	37	B2 acquires H	54:20
16	A2 acquires H	42:45	38	B2 fires at H	54:32
17	B3 acquires H	42:46	39	B3 acquires H	54:51
18	B2 acquires H	42:48	40	B3 acquires H	58:30
19	A2 acquires H	42:51			
20	B2 acquires H	44:07	41	H picks up DKE	58:50
21	B1 acquires H	44:08			

TABLE B11

Reconstruction of Events in Run 3-3

(ENTAC, active helicopter, stationary targets)

Symbol	Event	Elapsed time, min:sec	Symbol	Event	Elapsed time, min:sec
1	B3 acquires H	8:34	21	A2 fires at H	43:07
2	A2 acquires H	8:37	22	A1 acquires H	43:21
3	B2 acquires H	10:23	23	B1 acquires H	43:25
4	H dismounts DKE	12:05	24	B1 fires at H	43:32
			25	B2 acquires H	43:33
5	B1 acquires H	17:49	26	B2 fires at H	43:33
6	B3 acquires H	17:50	27	A3 acquires H	43:37
7	A2 acquires H	17:56	28	A3 fires at H	43:43
8	B3 acquires H	18:28	29	A2 acquires H	43:56
9	B1 acquires H	21:39	30	A2 fires at H	43:59
10	A2 acquires H	21:43	31	H picks up DKE	49:35
11	A2 fires at H	21:47			
12	B2 acquires H	22:21	32	B3 acquires H	51:33
13	A2 acquires H	36:56	33	B1 acquires H	51:34
14	A1 acquires H	37:35	34	A2 acquires H	51:38
15	DKE fires at A	42:21	35	B1 fires at H	51:39
16	B1 acquires DKE	42:38	36	A1 fires at H	51:42
17	B1 fires at DKE	42:43	37	A2 fires at H	51:46
18	A3 acquires DKE	42:43	38	B1 acquires H	51:49
19	H fires at A	42:55	39	B1 fires at H	51:49
20	A2 acquires H, DKE	43:03	40	A2 acquires H	51:59

TABLE B12

Reconstruction of Events in Run 3-4

(ENTAC, active helicopter, stationary targets)

Symbol	Event	Elapsed time, min:sec	Symbol	Event	Elapsed time, min:sec
1	B3 acquires H	7:15	14	A2 fires at H	26:16
2	B1 acquires H	9:46	15	H fires at A	26:28
3	B1 fires at H	9:50	16	A1 acquires H	26:50
4	B3 fires at H	10:01	17	A1 fires at H	26:53
5	H dismounts DKE	15:35	18	A2 acquires H	26:54
			19	A2 fires at H	26:54
6	B3 acquires H	19:09	20	B1 acquires H	26:57
7	B1 acquires H	19:10	21	B2 acquires H	27:30
8	B1 fires at H	19:14	22	B1 acquires H	27:31
9	A3 acquires DKE	23:50	23	B3 acquires H	27:31
10	A3 fires at DKE	24:00	24	B2 fires at H	27:34
11	A1 acquires H	26:05	25	B1 fires at H	27:34
12	A1 fires at H	26:07	26	B3 fires at H	27:38
13	A2 acquires H	26:12			

TABLE B13

Reconstruction of Events in Run 4-1

(ENTAC, active helicopter, fluid targets)

Symbol	Event	Elapsed time, min:sec	Symbol	Event	Elapsed time, min:sec
1	H dismounts DKE	10:03	9	S1 acquires H	52:01
			10	S3 fires at H	52:08
2	DKE fires at C	50:10	11	S2 fires at H	52:09
3	C1 acquires DKE	50:12	12	C1 fires at H	52:10
4	C1 acquires H	51:56	13	S1 fires at H	52:10
5	C2 acquires H	51:57	14	S2 acquires H	52:23
6	S2 acquires H	51:58	15	S2 fires at H	52:32
7	S3 acquires H	51:58			
8	H fires at C	52:00	16	H picks up DKE	56:57

TABLE B14

Reconstruction of Events in Run 4-2

(ENTAC, active helicopter, fluid targets)

Symbol	Event	Elapsed time, min:sec	Symbol	Event	Elapsed time, min:sec
1	C2 acquires H	16:36	16	S3 acquires H	32:34
2	S3 acquires H	20:03	17	S3 fires at h	32:42
3	S3 fires at H	20:24	18	S3 acquires H	33:31
4	S2 acquires H	21:33	19	S3 fires at H	33:44
5	S3 acquires H	22:30	20	C1 acquires H	33:52
6	S2 acquires H	22:31	21	C1 fires at H	34:03
7	S1 acquires H	22:40	22	DKE fires at C	74:44
8	H dismounts DKE	24:49	23	C1 acquires DKE	74:59
			24	C1 fires at DKE	75:07
9	S3 acquires H	25:49	25	C2 acquires DKE	75:17
10	S3 fires at H	25:52	26	C2 fires at DKE	75:20
11	C1 acquires H	26:06	27	H fires at C	75:29
12	C1 fires at H	26:40	28	C1 acquires H	75:35
13	C2 acquires H	26:59	29	C1 fires at H	75:39
14	S1 acquires H	30:51			
15	S1 fires at H	30:59	30	H picks up DKE	85:14

TABLE B15

Reconstruction of Events in Run 4-3

(ENTAC, active helicopter, fluid targets)

Symbol	Event	Elapsed time, min:sec	Symbol	Event	Elapsed time, min:sec
1	S2 acquires H	24:11	9	DKE fires at C	64:07
2	S2 acquires H	24:50	10	H fires at C	64:55
3	S2 fires at H	25:01	11	C1 acquires DKE	65:00
4	S2 acquires H	25:33	12	C2 acquires H	65:02
5	S2 fires at H	25:34	13	S2 acquires H	65:36
6	H dismounts DKE	33:45	14	C1 acquires H	68:31
			15	C1 acquires H	71:08
7	S3 acquires H	37:10			
8	S1 acquires H	61:49	16	H picks up DKE	74:55

TABLE B16

Reconstruction of Events in Run 4-4

(ENTAC, active helicopter, fluid targets)

Symbol	Event	Elapsed time, min:sec	Symbol	Event	Elapsed time, min:sec
1	H dismounts DKE	11:49	6	C2 fires at H	34:10
			7	H fires at C	34:11
2	DKE fires at C	34:01	8	S1 acquires H	34:43
3	C1 acquires DKE	34:03	9	S1 fires at H	34:45
4	C1 fires at DKE	34:08			
5	C2 acquires H	34:08	10	H picks up DKE	40:21

TABLE B17

Reconstruction of Events in Run 5-1

(ENTAC, passive helicopter, stationary targets)

Symbol	Event	Elapsed time, min:sec	Symbol	Event	Elapsed time, min:sec
1	A1 acquires H	10:36	5	A1 fires at DKE	33:51
2	H dismounts DKE	12:30	6	A1 acquires H	44:21
3	A1 acquires DKE	33:45	7	H picks up DKE	46:54
4	DKE fires at A	33:49			

TABLE B18

Reconstruction of Events in Run 5-2

(ENTAC, passive helicopter, stationary targets)

Symbol	Event	Elapsed time, min:sec	Symbol	Event	Elapsed time, min:sec
1	B2 acquires H	14:34	11	B3 fires at H	19:03
2	B2 acquires H	17:26	12	A1 acquires H	19:31
3	B3 acquires H	17:30	13	H dismounts DKE	20:10
4	B2 fires at H	17:31			
5	A1 acquires H	18:16	14	A3 acquires H	39:50
6	A2 acquires H	18:30	15	A3 fires at H	39:56
7	A3 acquires H	18:31	16	DKE fires at A	47:40
8	B3 acquires H	18:41	17	A3 acquires DKE	48:15
9	B2 acquires H	18:49	18	A3 fires at DKE	48:17
10	B2 fires at H	18:53			

TABLE B19

Reconstruction of Events in Run 5-3

(ENTAC, passive helicopter, stationary targets)

Symbol	Event	Elapsed time, min:sec	Symbol	Event	Elapsed time, min:sec
1	H dismounts DKE	10:27	3	H picks up DKE	92:00
2	B3 acquires H	13:26			

TABLE B20

Reconstruction of Events in Run 5-4

(ENTAC, passive helicopter, stationary targets)

Symbol	Event	Elapsed time, min:sec	Symbol	Event	Elapsed time, min:sec
1	A1 acquires H	9:22	17	A2 acquires H	10:47
2	B1 acquires H	9:23	18	A2 fires at H	10:51
3	A1 fires at H	9:26	19	B1 acquires H	10:54
4	B2 acquires H	9:27	20	B2 acquires H	10:56
5	B1 fires at H	9:27	21	B1 fires at H	11:00
6	B2 fires at H	9:35	22	B2 fires at H	11:04
7	B3 acquires H	9:38	23	B3 acquires H	11:07
8	A2 acquires H	9:40	24	A2 acquires H	11:11
9	A3 acquires H	9:45	25	A2 fires at H	11:14
10	B2 acquires H	9:54	26	H dismounts DKE	14:09
11	B2 fires at H	9:56			
12	B1 acquires H	10:10	27	DKE fires at A	29:11
13	B1 fires at H	10:16	28	A1 acquires H	35:14
14	B3 acquires H	10:34	29	A1 fires at H	35:21
15	A1 acquires H	10:44			
16	A1 fires at H	10:47	30	H picks up DKE	35:41

TABLE B21

Reconstruction of Events in Run 6-1

(ENTAC, passive helicopter, fluid targets)

Symbol	Event	Elapsed time, min:sec	Symbol	Event	Elapsed time, min:sec
1	C2 acquires H	6:20	4	H picks up DKE	25:20
2	C1 acquires H	6:22			
3	H dismounts DKE	14:40			

TABLE B22

Reconstruction of Events in Run 6-2

(ENTAC, passive helicopter, fluid targets)

Symbol	Event	Elapsed time, min:sec	Symbol	Event	Elapsed time, min:sec
1	H dismounts DKE	16:18	6	C2 fires at DKE	47:21
			7	H picks up DKE	57:12
2	DKE fires at C	47:11			
3	S2 acquires DKE	47:11	8	C1 acquires H	67:17
4	C1 acquires DKE	47:11	9	C1 fires at H	67:18
5	C2 acquires DKE	47:13			

TABLE B23

Reconstruction of Events in Run 6-3

(ENTAC, passive helicopter, fluid targets)

Symbol	Event	Elapsed time, min:sec	Symbol	Event	Elapsed time, min:sec
1	H dismounts DKE	12:33	3	C2 acquires H	15:04
2	C1 acquires H	14:26	4	H picks up DKE	24:10

TABLE B24

Reconstruction of Events in Run 6-4

(ENTAC, passive helicopter, fluid targets)

Symbol	Event	Elapsed time, min:sec	Symbol	Event	Elapsed time, min:sec
1	C1 acquires H	8:15	18	C1 fires at H	20:05
2	C1 fires at H	8:24	19	S2 acquires H	20:12
3	S1 acquires H	9:50	20	S2 fires at H	20:44
4	S3 acquires H	10:20	21	C2 acquires H	24:30
5	C2 acquires H	10:20	22	C2 fires at H	24:36
6	C2 fires at H	10:20	23	C1 acquires H	26:12
7	S3 fires at H	10:42	24	C1 fires at H	27:36
8	S1 acquires H	12:46	25	C2 acquires H	28:46
9	H dismounts DKE	14:23	26	C2 fires at H	28:48
			27	S1 acquires H	29:00
10	S1 acquires H	15:08	28	S3 acquires H	29:18
11	S1 fires at H	15:18	29	S3 fires at H	29:20
12	S1 acquires H	16:12	30	S1 fires at H	29:36
13	S1 fires at H	16:32	31	DKE fires at C	33:48
14	S1 acquires H	18:50	32	C1 acquires DKE	34:00
15	C2 acquires H	19:30	33	C2 acquires DKE	34:02
16	C2 fires at H	19:32	34	C1 fires at DKE	34:07
17	C1 acquires H	19:58	35	C2 fires at DKE	34:08

TABLE B25

Reconstruction of Events in Run 7-1

(Recoilless rifle, active helicopter, stationary targets)

Symbol	Event	Elapsed time, min:sec	Symbol	Event	Elapsed time, min:sec
1	B1 acquires H	6:32	20	B1 fires at H	28:52
2	B2 acquires H	7:21	21	B2 fires at H	28:54
3	B2 fires at H	7:25	22	B3 fires at H	28:57
4	B1 acquires H	9:09	23	H fires at A	29:08
5	B3 acquires H	9:10	24	DKE fires at A	35:09
6	B2 acquires H	9:13	25	A1 acquires DKE	35:10
7	B1 fires at H	9:15	26	A2 acquires DKE	35:17
8	B2 fires at H	9:19	27	A1 acquires H	35:44
9	B3 fires at H	9:30	28	A1 fires at H	35:46
10	H dismounts DKE	10:36	29	A2 acquires H	35:56
			30	B3 acquires H	35:58
11	A1 acquires H	28:18	31	B1 acquires H	35:59
12	A1 fires at H	28:22	32	B2 acquires H	36:01
13	A2 acquires H	28:33	33	B1 fires at H	36:02
14	A3 acquires H	28:43	34	A3 acquires H	36:02
15	B3 acquires H	28:45	35	B3 fires at H	36:04
16	A2 fires at H	28:47	36	A3 acquires DKE	37:08
17	A3 fires at H	28:47	37	A3 fires at DKE	37:09
18	B1 acquires H	28:49			
19	B2 acquires H	28:51	38	H picks up DKE	54:01

TABLE B26

Reconstruction of Events in Run 7-2

(Recoilless rifle, active helicopter, stationary targets)

Symbol	Event	Elapsed time, min:sec	Symbol	Event	Elapsed time, min:sec
1	B2 acquires H	17:47	13	B2 fires at H	43:30
2	B3 acquires H	17:48	14	B1 acquires H	43:31
3	B1 acquires H	20:14	15	A3 acquires H	43:35
4	B1 fires at H	20:18	16	A3 fires at H	43:37
5	A2 acquires H	20:35	17	H fires at A	43:38
6	H dismounts DKE	20:38	18	A2 acquires H	43:38
			19	A1 acquires H	43:39
7	A1 acquires DKE	42:40	20	A2 fires at H	43:40
8	A2 acquires DKE	42:42	21	A1 fires at H	43:41
9	DKE fires at A	42:53	22	B3 fires at H	43:48
10	A2 fires at DKE	43:12			
11	B3 acquires H	43:28	23	H picks up DKE	45:12
12	B2 acquires H	43:29			

TABLE B27

Reconstruction of Events in Run 7-3

(Recoilless rifle, active helicopter, stationary targets)

Symbol	Event	Elapsed time, min:sec	Symbol	Event	Elapsed time, min:sec
1	A2 acquires H	6:48	7	A2 acquires H	12:20
2	H dismounts DKE	7:26	8	A2 fires at H	12:24
			9	B3 acquires H	12:27
3	A3 acquires DKE	7:26	10	B1 acquires H	12:28
4	A3 fires at H, DKE	8:02	11	B2 acquires H	12:34
5	A1 acquires H	11:58	12	A2 acquires DKE	13:40
6	A3 acquires H	12:10	13	A2 fires at DKE	13:51

TABLE B28

Reconstruction of Events in Run 7-4

(Recoilless rifle, active helicopter, stationary targets)

Symbol	Event	Elapsed time, min:sec	Symbol	Event	Elapsed time, min:sec
1	A3 acquires H	5:52	11	B1 acquires H	37:00
2	A3 acquires H	8:15	12	B1 acquires H	85:20
3	H dismounts DKE	16:05	13	A3 acquires H	103:24
			14	H fires at A	103:25
4	B3 acquires H	20:36	15	A3 fires at H	103:30
5	B3 acquires H	22:26	16	A2 acquires H	103:32
6	B1 acquires H	22:41	17	A1 acquires H	103:40
7	B3 fires at H	22:44	18	A1 fires at H	103:41
8	B1 fires at H	22:45	19	A2 fires at H	103:43
9	B1 acquires H	25:26	20	B1 acquires H	103:48
10	B1 acquires H	36:14	21	H picks up DKE	110:00

TABLE B29

Reconstruction of Events in Run 8-1

(Recoilless rifle, active helicopter, fluid targets)

Symbol	Event	Elapsed time, min:sec	Symbol	Event	Elapsed time, min:sec
1	H dismounts DKE	16:15	5	C1 acquires DKE	67:43
			6	S1 fires at DKE	67:45
2	DKE fires at S	67:40	7	S2 fires at DKE	67:45
3	S1 acquires DKE	67:41	8	C1 fires at DKE	67:54
4	S2 acquires DKE	67:41	9	H fires at C	69:55

TABLE B30

Reconstruction of Events in Run 8-2

(Recoilless rifle, active helicopter, fluid targets)

Symbol	Event	Elapsed time, min:sec	Symbol	Event	Elapsed time, min:sec
1	H dismounts DKE	15:09	7	C2 acquires H	77:53
			8	C2 fires at H	77:56
2	S1 acquires H	77:12	9	S3 acquires H	77:58
3	S1 fires at H	77:23	10	S3 acquires H	78:18
4	H fires at C	77:29	11	S3 fires at H	78:23
5	C1 acquires H	77:40			
6	C1 fires at H	77:52	12	H picks up DKE	87:49

TABLE B31

Reconstruction of Events in Run 8-3

(Recoilless rifle, active helicopter, fluid targets)

Symbol	Event	Elapsed time, min:sec	Symbol	Event	Elapsed time, min:sec
1	H dismounts DKE	7:40	11	S1 fires at H	36:03
			12	H fires at C2	37:25
2	C1 acquires H	8:26	13	C1 acquires H	37:28
3	S2 acquires H	9:08	14	C1 fires at H	37:29
4	DKE fires at C	35:30	15	C2 acquires H	37:32
5	S2 acquires DKE	35:37	16	S3 acquires H	37:32
6	C1 acquires DKE	35:38	17	C2 fires at H	37:34
7	C2 acquires DKE	35:40	18	S2 acquires H	37:40
8	S1 acquires H	35:44	19	S1 acquires DKE	41:26
9	C2 fires at DKE	35:44	20	S1 acquires DKE	44:27
10	C1 fires at DKE	35:46	21	S1 fires at DKE	44:29

TABLE B32

Reconstruction of Events in Run 8-4

(Recoilless rifle, active helicopter, fluid targets)

Symbol	Event	Elapsed time, min:sec	Symbol	Event	Elapsed time, min:sec
1	H dismounts DKE	9:09	9	C1 acquires H	37:50
			10	H fires at C	37:54
2	DKE fires at C	36:51	11	S2 acquires DKE	40:18
3	C2 acquires DKE	36:52	12	S2 fires at DKE	40:18
4	C1 acquires DKE	36:53	13	H picks up DKE	51:38
5	C2 fires at DKE	36:57			
6	C1 fires at DKE	37:02	14	C1 acquires H	52:39
7	S1 acquires H	37:26	15	C1 fires at H	52:48
8	S1 fires at H	37:49			

TABLE B33

Reconstruction of Events in Run 9-1

(Recoilless rifle, passive helicopter, stationary targets)

Symbol	Event	Elapsed time, min:sec	Symbol	Event	Elapsed time, min:sec
1	B1 acquires H	5:38	14	A1 fires at H	15:18
2	A2 acquires H	5:48	15	A3 acquires H	15:53
3	A3 acquires H	5:48	16	A1 acquires H	15:54
4	B1 acquires H	6:00	17	A1 fires at H	15:57
5	B3 acquires H	6:03	18	B3 acquires H	16:14
6	B1 fires at H	6:04	19	H dismounts DKE	17:15
7	A3 acquires H	13:46			
8	A2 acquires H	13:51	20	B3 acquires H	18:10
9	A3 fires at H	13:51	21	DKE fires at A	23:23
10	A1 acquires H	13:54	22	A2 acquires DKE	23:29
11	A1 fires at H	14:00			
12	A1 acquires H	14:13	23	H picks up DKE	24:55
13	A1 acquires H	15:50			

TABLE B34

Reconstruction of Events in Run 9-2

(Recoilless rifle, passive helicopter, stationary targets)

Symbol	Event	Elapsed time, min:sec	Symbol	Event	Elapsed time, min:sec
1	A2 acquires H	1:51	7	A3 acquires DKE	29:49
2	A2 acquires H	5:23	8	A3 acquires DKE	29:59
3	A1 acquires H	5:25	9	A2 acquires DKE	32:07
4	B1 acquires H	5:43	10	A2 fires at DKE	32:09
5	H dismounts DKE	7:32	11	B1 acquires H	37:35
6	DKE fires at A	29:42	12	H picks up DKE	40:13

TABLE B35

Reconstruction of Events in Run 9-3

(Recoilless rifle, passive helicopter, stationary targets)

Symbol	Event	Elapsed time, min:sec	Symbol	Event	Elapsed time, min:sec
1	A3 acquires H	8:08	8	A2 acquires H	10:58
2	B3 acquires H	8:51	9	H dismounts DKE	11:15
3	A3 acquires H	8:54			
4	B1 acquires H	10:21	10	A3 acquires H	38:54
5	B2 acquires H	10:24	11	A3 acquires DKE	39:01
6	B1 fires at H	10:24	12	A3 fires at DKE	39:03
7	B3 acquires H	10:26			

TABLE B36

Reconstruction of Events in Run 9-4

(Recoilless rifle, passive helicopter, stationary targets)

Symbol	Event	Elapsed time, min:sec	Symbol	Event	Elapsed time, min:sec
1	A2 acquires H	5:03	6	B1 acquires DKE	23:52
2	A2 acquires H	5:29	7	B2 acquires DKE	23:52
3	H dismounts DKE	9:02	8	A1 acquires DKE	23:52
			9	A2 acquires DKE	23:52
4	A2 acquires H	19:11	10	A3 acquires DKE	23:52
5	DKE fires at A	23:50	11	A3 fires at DKE	23:54

TABLE B37

Reconstruction of Events in Run 10-1

(Recoilless rifle, passive helicopter, fluid targets)

Symbol	Event	Elapsed time, min:sec	Symbol	Event	Elapsed time min:sec
1	H dismounts DKE	8:38	7	DKE fires at S	56:17
			8	S1 acquires DKE	56:22
2	DKE fires at C	50:09	9	S1 fires at DKE	56:24
3	C1 acquires DKE	50:18	10	H picks up DKE	62:53
4	C2 acquires DKE	50:24			
5	C2 fires at DKE	50:33	11	S2 acquires H	63:00
6	C1 fires at DKE	50:36			

TABLE B38

Reconstruction of Events in Run 10-2

(Recoilless rifle, passive helicopter, fluid targets)

Symbol	Event	Elapsed time, min:sec	Symbol	Event	Elapsed time min:sec
1	H dismounts DKE	12:32	4	DKE fires at C	36:46
			5	C1 acquires DKE	36:46
2	S1 acquires DKE	35:50	6	S2 acquires DKE	36:46
3	S1 fires at DKE	36:40	7	S2 fires at DKE	36:49

TABLE B39

Reconstruction of Events in Run 10-3

(Recoilless rifle, passive helicopter, fluid targets)

Symbol	Event	Elapsed time, min:sec	Symbol	Event	Elapsed time, min:sec
1	H dismounts DKE	10:03	5	C1 fires at DKE	39:55
			6	C2 fires at DKE	40:28
2	DKE fires at C	39:40			
3	C2 acquires DKE	39:44	7	H picks up DKE	46:33
4	C1 acquires DKE	39:45			

TABLE B40

Reconstruction of Events in Run 10-4

(Recoilless rifle, passive helicopter, fluid targets)

Symbol	Event	Elapsed time, min:sec	Symbol	Event	Elapsed time min:sec
1	C2 acquires H	5:52	8	S2 acquires H	16:24
2	H dismounts DKE	6:42	9	S2 fires at H	16:48
			10	S2 acquires H	17:58
3	DKE fires at C	10:15	11	S2 fires at H	17:58
4	C1 acquires DKE	10:27	12	S2 acquires H	19:35
5	S3 acquires H	10:33	13	S2 fires at H	19:41
6	S3 fires at H	10:44			
7	H picks up DKE	11:50			

Appendix C

ANALYSIS OF KILLER-TEAM PERFORMANCE

Tables

This appendix presents a detailed analysis of killer-team performance during the experimental runs. It considers such factors as the ability of killer teams employing the various tactics studied to initiate engagements with enemy elements, to bring effective fire to bear on enemy target complexes, and to terminate engagements before becoming a casualty.

To a large extent the performance of killer teams depends on the measure of success considered. One type of killer team may appear superior to other types on the basis of one measure of mission success but inferior on the basis of another measure. The analyses presented below, therefore, will initially consider relatively simple standards which are generally considered essential for mission success and will then proceed to more complex measures.

For antiarmor missions of the type studied to have any chance of being successful the killer team must: (a) acquire at least one enemy tank target, (b) take the enemy target vehicle(s) under fire, and (c) be within the effective range of the antiarmor weapon at time(s) of fire. Table C1 presents a qualitative analysis of the number of killer-team missions on which these three basic requirements were met. This analysis, based on data from App A, showed that on 25 of the 40 missions the killer elements were able to engage at least one enemy target within the effective range of the antiarmor weapon. On a total of 15 other missions, however, no potentially effective killer-team firings were recorded. The major reason for the lack of killer-team success on each of these missions is presented in Table C2.

This analysis of killer-team performance will now be narrowed to a consideration of those runs on which the killer team had some chance of success. The number of potentially effective killer-element firings during these runs varied greatly. Data indicating the number of enemy targets taken under fire and the number of missiles or rounds fired at each target are presented in Table C3. In this table, each target taken under fire per run has been designated by a different alphabetic character and each firing has been associated with a firer target range.

The data presented in Table C3 are shown in summary form in Table C4. From Table C4 it can be seen that:

(a) Teams with dismounted recoilless-rifle crews fired at more enemy targets per run and more times per run than teams with the other two types of weapons studied. These results can be attributed to (a) recoilless-rifle crews generally were successful in coordinating their attacks—whenever possible each 2-man crew selected a different enemy target and attempted to fire at the same time their dismounted teammates fired and (b) the recoilless-rifle teams were able to fire more rounds per target engaged than SS-11 or ENTAC gunners, because of the high rate of fire for the M67 90-mm recoilless rifle in relation to the rate at which the missiles can be launched and guided to their targets.

TABLE C1

Analysis of Killer-Team Performance

(Based on firings within effective range of antiarmor weapon)

Experimental run	Activity of killer elements with antiarmor weapon		
	Acquired target	Fired at target	Fired within effective range
1-1	Yes	Yes	Yes
1-2	Yes	Yes	Yes
1-3	Yes	Yes	Yes
1-4	No	No	No
2-1	Yes	Yes	Yes
2-2	No	No	No
2-3	Yes	Yes	Yes
2-4	Yes	Yes	Yes
3-1	No	No	No
3-2	No	No	No
3-3	Yes	Yes	Yes
3-4	Yes	No	No
4-1	Yes	Yes	Yes
4-2	Yes	Yes	Yes
4-3	Yes	Yes	Yes
4-4	Yes	Yes	Yes
5-1	Yes	Yes	Yes
5-2	Yes	Yes	No
5-3	No	No	No
5-4	Yes	Yes	Yes
6-1	Yes	No	No
6-2	Yes	Yes	Yes
6-3	Yes	No	No
6-4	Yes	Yes	Yes
7-1	Yes	Yes	Yes
7-2	Yes	Yes	Yes
7-3	No	No	No
7-4	No	No	No
8-1	No	No	No
8-2	No	No	No
8-3	Yes	Yes	Yes
8-4	Yes	Yes	Yes
9-1	Yes	Yes	Yes
9-2	Yes	Yes	Yes
9-3	No	No	No
9-4	Yes	Yes	No
10-1	Yes	Yes	Yes
10-2	Yes	Yes	Yes
10-3	Yes	Yes	Yes
10-4	Yes	Yes	Yes

TABLE C2

Analysis of Unsuccessful Killer-Team Missions

Reason for failure of killer-team attack	SS-11/UH-1		ENTAC				Recoilless rifle				Total
			Active helicopter		Passive helicopter		Active helicopter		Passive helicopter		
	Against stationary targets	Against fluid targets	Against stationary targets	Against fluid targets	Against stationary targets	Against fluid targets	Against stationary targets	Against fluid targets	Against stationary targets	Against fluid targets	
	Runs										
No enemy tanks acquired	1	1	2	0	1	0	1	1	0	0	7
Ambush position established too late	0	0	0	0	0	2	0	0	0	0	2
Intercepted by enemy security elements	0	0	1	0	0	0	1	1	1	0	4
Fired out of effective range	0	0	0	0	1	0	0	0	1	0	2
Total completely unsuccessful missions	1	1	3	0	2	2	2	2	2	0	15

TABLE C3

Killer-Team Firings on Potentially Successful Missions

Experimental run	Designation of enemy-target vehicle	Times target vehicle fired at	Target-killer team range for each firing, m
1-1	X	1	2000
1-2	X[a]	3[b]	1200, 1200, 2000
	Y	2	900, 1300
1-3	X	1[c]	1000
	Y	1[c]	2000
2-1	X	1	1500
2-3	X	1	1500
2-4	X	1	2000
3-3	X	1	1300
4-1	X	2	800, 800
4-2	X	2	500, 500
4-3	X	1	1400
	Y	1	1400
4-4	X	1	1500
	Y	1	1500
5-1	X	1	550
	Y	1	550
5-4	X	1	1000
	Y	1	1000
6-2	X	1	800
	Y	1	800
6-4	X	1	700
7-1	X	2	30, 30
	Y	2	30, 30
7-2	X	2	200, 200
	Y	2	200, 200
8-3	X	2	150, 150
	Y	2	200, 200
8-4	X	2	200, 200
	Y	2	200, 200
9-1	X	2	350, 350
	Y	2	350, 350
9-2	X	2	200, 200
	Y	2	400, 400
10-1	X	2	200, 200
	Y	2	200, 200
10-2	X	2	150, 150
10-3	X	2	30, 30
	Y	2	80, 80
10-4	X	2	100, 100
	Y	2	100, 100

[a]B-complex vehicle.
[b]Includes two firings by H2.
[c]Firing by H2.

(b) Dismounted killer elements fired at slightly more targets and more frequently on runs in which they did not receive active helicopter support than on runs in which support was provided. Thus helicopter assistance during the attack phase of the killer-team mission did not enhance the ability of DKEs to acquire and fire at enemy target vehicles.

(c) The killer elements were noticeably more effective against fluid enemy vehicles than against targets in stationary complexes.

TABLE C4

Summary Comparisons of Killer-Team Firing Data

Type of killer elements	Enemy targets fired at			Total firings		
	Stationary	Fluid	Total	Stationary	Fluid	Total
SS-11/UH-1	5	3	8	8	3	11
ENTAC						
Active	1	6	7	1	8	9
Passive	4	3	7	4	3	7
Total ENTAC	5	9	14	5	11	16
Recoilless rifle						
Active	4	4	8	8	8	16
Passive	4	7	11	8	14	22
Total recoilless rifle	8	11	19	16	22	38
DKE						
Active helicopters	5	10	15	9	16	25
Passive helicopters	8	10	18	12	17	29
Total DKE	13	20	33	21	33	54

Although the killer elements fired at a total of 41 vehicles within the effective range of their antiarmor weapons, not all the targets taken under fire would have been destroyed. Under actual combat conditions, many of the firings would have resulted in misses and several in hits but not in kills. Given the data shown in Table C3 and hit-and-kill information[14,15] the expected number of target vehicles killed during each run can be calculated by applying the methodology illustrated in Table C5. An analysis of this kind, based on the probability of incapacitating either the firepower or mobility system of the enemy vehicle (i.e., of obtaining either an F or an M kill), indicated that 20 of the 41 vehicles fired at would be killed. Of these 20 kills, 4 were scored by SS-11/UH-1 killer teams, 3 by ENTAC teams with active helicopter support, 2 by ENTAC teams with passive support, 5 by recoilless-rifle teams with active helicopters, and 6 by recoilless rifles with passive helicopters. Of the 20 kills, 8 were scored against stationary targets and 12 against fluid targets. Dismounted killer elements obtained 8 expected kills with helicopter support, and 8 expected kills without helicopter support during the attack phase of the killer-team mission.

The estimate of 20 expected kills overstates killer-team performance because it does not take into account firings at killer-team elements by the

TABLE C5

Illustration of Method Used To Calculate Expected Number of Kills[a]

Experimental run	Designation of enemy target vehicle	Number of round in firing sequence	Target-killer-team range at time of firing, m	Probability of target hit at range specified in (4) for round	Probability of target kill, given a hit	Probability that target is still alive at time of fire of round	Probability of killing a live target on round P_{K_n} (5) × (6) × (7)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1-1	X	1	2000	P_{h_1}	$P_{k/h}$	1.00	$P_{h_1} \times P_{k/h} \times 1.00$
1-2	X	1	1200	P_{h_1}	$P_{k/h}$	1.00	$P_{h_1} \times P_{k/h} \times 1.00$
		2	1200	P_{h_2}	$P_{k/h}$	$1.00 - P_{K_1}$	$P_{h_2} \times P_{k/h} \times [1.00 - P_{K_1}]$
		3	2000	P_{h_3}	$P_{k/h}$	$1.00 - P_{K_1} - P_{K_2}$	$P_{h_3} \times P_{k/h} \times [1.00 - P_{K_1} - P_{K_2}]$
	Y	1	900	P_{h_1}	$P_{k/h}$	1.00	$P_{h_1} \times P_{k/h} \times 1.00$
		2	1300	P_{h_2}	$P_{k/h}$	$1.00 - P_{K_1}$	$P_{h_2} \times P_{k/h} \times [1.00 - P_{K_1}]$
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
10-4	X	1	100	P_{h_1}	$P_{k/h}$	1.00	$P_{h_1} \times P_{k/h} \times 1.00$
		2	100	P_{h_2}	$P_{k/h}$	$1.00 - P_{K_1}$	$P_{h_2} \times P_{k/h} \times [1.00 - P_{K_1}]$
	Y	1	100	P_{h_1}	$P_{k/h}$	1.00	$P_{h_1} \times P_{k/h} \times 1.00$
		2	100	P_{h_2}	$P_{k/h}$	$1.00 - P_{K_1}$	$P_{h_2} \times P_{k/h} \times [1.00 - P_{K_1}]$

[a]The "expected number of kills" on each run is obtained by summing the values in (8) for each run.

opposing side prior to the 41 killer-team firings. Ideally, this consideration should have been introduced before estimating the expected number of ground-complex vehicles destroyed. This was not done, however, because a portion of the range data for ground-element firings at killer elements was not as complete as is desirable for calculating hit probabilities and because it was not possible in several cases to determine which of two identical killer elements was taken under fire.

TABLE C6

Ground-Element Firings against Killer-Team Elements

(Prior to killer-team fire)

Experimental run	Against helicopters prior to first SS-11 launch or killer-element dismount		Against DKEs prior to ENTAC or recoilless-rifle firing	
	Firings	Time under fire, sec	Firings	Time under fire, sec
1-1	2	5	—	—
1-2	8	91	—	—
1-3	13	61	—	—
2-1	1	15	—	—
2-3	5	90	—	—
2-4	1	1	—	—
3-3	0	0	0	0
4-1	0	0	0	0
4-2	1	13	0	0
4-3	2	7	0	0
4-4	0	0	0	0
5-1	0	0	0	0
5-4	10	75	0	0
6-2	0	0	0	0
6-4	3	15	0	0
7-1	4	80	0	0
7-2	1	12	0	0
8-3	0	0	0	0
8-4	0	0	0	0
9-1	5	23	0	0
9-2	0	0	0	0
10-1	0	0	0	0
10-2	0	0	1	6
10-3	0	0	0	0
10-4	0	0	0	0

The summary data provided in Table C6 furnish several interesting insights into killer-element status prior to fire. These data indicate that:

(a) On all 8 runs involving the SS-11/UH-1 weapons system the lead helicopter was fired at before missile launch.

(b) Aircraft transporting heliborne infantry, however, were fired on only 7 of 19 missions prior to dismounting the killer elements.

(c) On 18 of the 19 runs in which dismounted elements fired within the effective range of their antiarmor weapons the killer elements were not taken under fire before they were able to fire at enemy targets.

TABLE C7

Ground-Element Firings against DKEs

(After killer-team fire)

Experimental run	Action against DKEs after ENTAC or recoilless-rifle firing	
	Firings	Time under fire, sec
3-3	1	4
4-1	0	0
4-2	2	31
4-3	0	0
4-4	1	6
5-1	1	2
5-4	0	0
6-2	1	6
6-4	2	20
7-1	1	7
7-2	1	2
8-3	3	29
8-4	3	14
9-1	0	0
9-2	1	1
10-1	3	21
10-2	1	18
10-3	2	23
10-4	0	0

TABLE C8

Comparison of Ground-Element Firings against DKEs

(After killer-team fire)

Comparison	Times DKEs fired at	Time DKEs under fire, sec	Number of experimental runs
Elements			
ENTAC	8	69	9
Recoilless-rifle	15	115	10
Support			
Active	12	93	9
Passive	11	91	10
Targets			
Stationary	5	16	7
Fluid	18	168	12

Data concerning ground-complex action against DKE after killer-team fire are presented in Table C7. As in the case of ground-complex firings against helicopters, it was very difficult to reconstruct the details of ground-element firings against DKE personnel. From the summary data provided in Table C8, however, it can be seen that:

(a) Almost twice as much return fire was directed at recoilless-rifle crews as at ENTAC teams.

TABLE C9

Analysis of Helicopter Suppressive Fire

(in support of DKEs)

Experimental run	Sequence of ground-element firing against DKEs after DKEs fire at target vehicles	Designation of ground-element engaging DKEs	Time between DKEs fire and ground-element return fire, sec	Duration of ground-element return fire at DKEs, sec	Time between DKEs fire and end of ground-element return fire, sec (4) + (5)	Time between DKEs fire and beginning of helicopter suppressive fire, sec	Duration of ground-element fire against DKEs occuring after beginning of helicopter suppressive fire, sec
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
3-3	1	B1	22	4	26	34	0
4-1	—[a]	—	—	—	—	110	—
4-2	1	C1	23	10	33	45	0
	2	C2	36	21	57	45	12
4-3	—[a]	—	—	—	—	48	—
4-4	1	C1	7	6	13	40	0
7-1	1	A3	120	7	127	—[b]	—
7-2	1	A2	19	2	21	45	0
8-3	1	C2	14	10	24	115	0
	2	C1	16	9	25	115	0
	3	S1	537	10	547	—[c]	—
8-4	1	C2	6	2	8	63	0
	2	C1	9	2	11	63	0
	3	S2	207	10	217	—[c]	—

[a]No ground-element firings against DKE after DKE fire at ground targets.
[b]No helicopter suppressive fire provided.
[c]Helicopter suppressive fire provided against C1 and C2 only.

(b) After firing at enemy vehicles, DKEs were subjected to approximately the same amount of fire on runs with and without helicopter support. Supplementary analyses, presented in Table C9, revealed that of the 93 sec of fire directed at DKEs after the killer elements had fired at ground targets on runs with active helicopters, 82 sec occurred before the helicopters could provide any suppressive fire. At best, therefore, helicopter suppressive fire would have reduced the volume of ground-complex fire against DKEs by a total of only 12 sec.

(c) The amount of ground-complex activity against withdrawing killer-team elements was considerably greater on fluid runs than on killer-team missions against stationary target vehicles. These results can largely be attributed to the relatively heavy fire against recoilless-rifle crews withdrawing from ambush positions in cultivated fields bordering the column's route of march.

Appendix D

ANALYSIS OF GROUND-COMPLEX ACTION AGAINST KILLER-TEAM ELEMENTS

Figure

Tables

This appendix presents a detailed statistical analysis of the actions taken by ground-target elements against the attacking killer teams. This analysis is based on data presented in App B and in Tables 10 and 11.

The ability of killer-team elements to survive engagements with enemy vehicles depends largely on the amount of enemy activity encountered during the assigned mission. Four of the most important measures of ground-complex activity against killer-team elements are: (a) the number of times killer elements were sighted during their mission, (b) the number of times killer elements were fired on, (c) the duration of killer-team exposure to enemy view, and (d) the duration of fire sustained by the killer-team elements. Although none of these measures provides an estimate of the vulnerability of killer-team elements in absolute terms, each is useful in furnishing an estimate of the relative vulnerability of killer-team elements employing the different tactics studied.

The analysis of variance was the statistical technique used to analyze ground-complex activity involving killer-team elements (see Tables D1 to D12). This technique is quite helpful in pointing up any probability that observed "differences" in performance actually happened by chance. Table D1, for example, compares the observed performances of stationary and fluid ground vehicles against five types of killer teams (SS-11/UH-1, ENTAC with active helicopter, ENTAC with passive helicopter, 90-mm recoilless rifle with active helicopter, and 90-mm recoilless rifle with passive helicopter) on the basis of the number of times helicopters were sighted during the entry phase of the killer-team mission. This analysis indicates that the observed difference in the number of sightings scored by stationary compared with fluid ground vehicles is so great that the probability this difference occurred by chance is less than 0.01. In addition to the 0.01 probability level ($\epsilon = 0.01$), tests were also conducted to determine whether observed performance differences would be expected to occur by chance less than 5.0 percent of the time ($\epsilon = 0.05$) and less than 0.1 percent of the time ($\epsilon = 0.001$).

The analysis-of-variance techniques are also useful in identifying interactions between the major factors studied. In Table D5, for example, the result that the $T \times M$ factor is significant at the $\epsilon = 0.01$ level indicates that for the situation examined the effects of killer-team type and ground-vehicle movement are not independent of one another. Some combination(s) of killer team and ground-vehicle movement differs noticeably from other combinations, a finding illustrated in Fig. D1. From this figure it can be seen that stationary vehicles recorded about 3 times more helicopter sightings than fluid vehicles against four of the five types of killer teams studied. For the ENTAC with passive helicopter participation, however, the fluid vehicles scored significantly more acquisitions (or the stationary vehicles significantly less) than would have been expected from the outcomes of encounters with the other four types of killer teams. These results were attributed to the fact that on Run 6-4 (ENTAC, passive helicopter, fluid targets) the helicopter pilot did not withdraw to a

position outside the mission area as instructed and subsequently was caught on the ground by the entire enemy force.

An analysis of ground-complex performance against helicopters during the entry and attack portions of the killer-team mission is presented in Tables D1 to D12. In these analyses the main factors studied are the type of killer

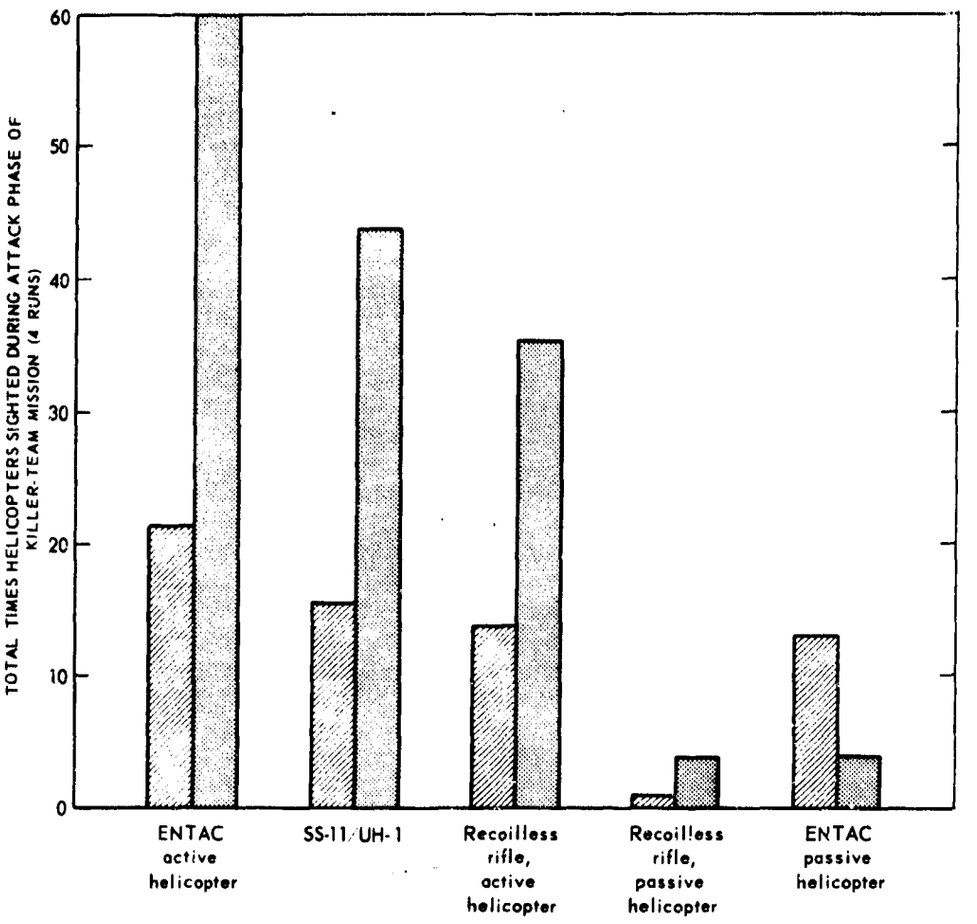


Fig. D1—Interaction between Type of Killer Team and Vehicle Movement

team (SS-11/UH-1, ENTAC with active helicopter, ENTAC with passive helicopter, recoilless rifle with active helicopter, and recoilless rifle with passive helicopter) and the effect of ground-vehicle movement (stationary, fluid). For Runs 1-1 to 1-4, 2-1, and 2-2 during which two UH-1B aircraft were employed, the total quantities of ground-complex activity against the helicopters have been divided by a factor of 2. The results of the analyses shown in Tables D1 to D12 indicate that:

(a) During the entry phase of the killer-team mission, significantly more helicopters were seen and fired at by stationary enemy elements than by fluid ones. Similarly, the period of exposure of entering helicopters was significantly longer to the stationary enemy vehicles than to fluid elements.

(b) During the period of killer-team attack the number of times that helicopters supporting some kinds of killer teams were fired at differed significantly from the number of times helicopters associated with other kinds of teams were taken under fire. Only one firing on eight runs, for example, was recorded by stationary and fluid enemy vehicles against passive helicopters transporting recoilless-rifle crews.

(c) Based on the entry and attack phases combined, significantly more ground acquisitions and firings were made against helicopters supporting some types of killer teams than others and significantly more acquisitions and firings by vehicles in stationary complexes than by vehicles in fluid complexes.

The data shown in Tables D1 to D12 indicate that the amount of enemy action observed against helicopters employed as weapon platforms for SS-11 missile launchings is substantial. The average number of times that helicopters equipped with the SS-11 system were acquired and taken under fire was greater than for helicopters in any other role examined. For this reason and because the employment of helicopters on this type of mission was different from the role of helicopters supporting dismounted elements, a set of statistical analyses was made that excluded the SS-11/UH-1 data. These analyses presented in Tables D13 to D24 compared the exposure of helicopters (a) in support of ENTAC vs recoilless-rifle crews, (b) on active vs passive missions, and (c) to stationary vs fluid enemy vehicles. From these 12 analyses it was found that:

(a) During the entry phase of the killer-team mission the number of times helicopters were acquired by stationary vehicles and the length of time they were within sight of stationary vehicles were significantly greater than for fluid vehicles.

(b) The number of times helicopters were sighted and taken under fire during the attack phase of the killer-team mission was noticeably different for some combinations of helicopter participation and target movement than for others. Helicopters providing active support, for example, were fired at a total of 51 times by stationary targets and only 22 times by fluid vehicles; on the other hand, passive helicopters were fired at only 2 times by stationary vehicles but 11 times by fluid enemy elements. The unexpectedly high number of times passive helicopters were fired at by fluid enemy vehicles was attributed to Run 6-4 during which the helicopter pilot deviated from the role prescribed for passive aircraft and was fired at 10 times by fluid enemy elements.

(c) Based on the number of times helicopters were acquired and fired at prior to retrieving the dismounted elements the amount of enemy activity against helicopters was significantly less on runs in which the helicopter assumed a passive role than on runs in which the helicopter provided active support.

(d) Vehicles in stationary ground complexes acquired noticeably more helicopters than vehicles in fluid situations.

The first 24 analyses presented in this appendix are based on ground-complex actions against the helicopter portion of the killer team. Analyses

TABLE D1

Two-Factor Analysis of Variance: Times Helicopter Was Sighted during Entry Phase of Killer-Team Mission

a. Classification

Killer team T	Ground target M							
	Stationary				Fluid			
	Times helicopter sighted during replication							
	R_1	R_2	R_3	R_4	R_1	R_2	R_3	R_4
SS-11	3	11	14	8	4	3	13	1
ENTAC								
Active	1	10	3	2	0	6	3	0
Passive	1	9	0	15	2	0	0	5
90-mm recoilless rifle								
Active	5	4	1	2	0	0	0	0
Passive	13	4	7	2	0	0	0	1

b. Analysis

Source of variation	Sum of squares	Degrees of freedom	Variance estimate
Team	136.2	4	34.0
Movement	148.2	1	148.2**
$T \times M$	22.7	4	5.7
Residual	472.8	30	15.8
Total	779.9	39	—

**Significance level $\epsilon = 0.01$.

TABLE D2

Two-Factor Analysis of Variance: Times Helicopter Was Fired at during Entry Phase of Killer-Team Mission

a. Classification

Killer team T	Ground target M							
	Stationary				Fluid			
	Times helicopter fired at during replication							
	R_1	R_2	R_3	R_4	R_1	R_2	R_3	R_4
SS-11	1	4	7	4	1	1	5	0
ENTAC								
Active	0	1	0	2	0	1	2	0
Passive	0	3	0	10	0	0	0	3
90-mm recoilless rifle								
Active	4	1	0	0	0	0	0	0
Passive	5	0	1	0	0	0	0	0

b. Analysis

Source of variation	Sum of squares	Degrees of freedom	Variance estimate
Team	31.9	4	8.0
Movement	22.5	1	22.5*
$T \times M$	7.8	4	1.9
Residual	139.5	30	4.7
Total	201.7	39	—

*Significance level $\epsilon = 0.05$.

TABLE D3

Two-Factor Analysis of Variance: Time Helicopter Was in View during Entry Phase of Killer-Team Mission

a. Classification

Killer team T	Ground target M							
	Stationary				Fluid			
	Total time helicopter in view during replication, sec							
	R_1	R_2	R_3	R_4	R_1	R_2	R_3	R_4
SS-11 ENTAC	46	224	232	152	37	128	393	56
Active	12	166	172	166	0	189	76	0
Passive	48	189	0	263	26	0	0	126
90-mm recoilless rifle								
Active	131	66	155	81	0	0	0	0
Passive	204	234	81	34	0	0	0	8

b. Analysis

Source of variation	Sum of squares	Degrees of freedom	Variance estimate
Team	52076.7	4	13019.2
Movement	65529.0	1	65529.0**
$T \times M$	18268.9	4	4567.2
Residual	233939.3	30	7798.0
Total	369813.9	39	—

**Significance level $\epsilon = 0.01$.

TABLE D4

Two-Factor Analysis of Variance: Time Helicopter Was under Fire during Entry Phase of Killer-Team Mission

a. Classification

Killer team T	Ground target M							
	Stationary				Fluid			
	Total time helicopter under fire during replication, sec							
	R_1	R_2	R_3	R_4	R_1	R_2	R_3	R_4
SS-11 ENTAC	3	43	31	34	8	6	90	0
Active	0	8	0	13	0	13	7	0
Passive	0	35	0	75	0	0	0	15
90-mm recoilless rifle								
Active	80	12	0	0	0	0	0	0
Passive	23	0	12	0	0	0	0	0

b. Analysis

Source of variation	Sum of squares	Degrees of freedom	Variance estimate
Team	2700.9	4	675.2
Movement	1322.5	1	1322.5
$T \times M$	1023.0	4	255.8
Residual	15420.0	30	514.0
Total	20466.4	39	—

TABLE D5

Two-Factor Analysis of Variance: Times Helicopter Was Sighted during Attack Phase of Killer-Team Mission

a. Classification

Killer team T	Ground target M							
	Stationary				Fluid			
	Times helicopter sighted during replication							
	R_1	R_2	R_3	R_4	R_1	R_2	R_3	R_4
SS-11	15	14	11	4	6	2	2	6
ENTAC								
Active	13	22	15	10	6	8	6	2
Passive	1	1	1	1	0	0	2	11
90-mm recoilless rifle								
Active	12	6	6	11	0	5	7	2
Passive	1	1	1	1	0	0	0	0

b. Analysis

Source of variation	Sum of squares	Degrees of freedom	Variance estimate
Team	495.7	4	123.9***
Movement	164.0	1	164.0***
$T \times M$	180.9	4	45.2**
Residual	330.3	30	11.0
Total	1170.9	39	—

**Significance level $\epsilon = 0.01$.
***Significance level $\epsilon = 0.001$.

TABLE D6

Two-Factor Analysis of Variance: Times Helicopter Was Fired at during Attack Phase of Killer-Team Mission

a. Classification

Killer team T	Ground target M							
	Stationary				Fluid			
	Times helicopter fired at during replication							
	R_1	R_2	R_3	R_4	R_1	R_2	R_3	R_4
SS-11	9	6	7	2	3	2	2	6
ENTAC								
Active	10	6	6	8	5	7	0	2
Passive	0	1	0	1	0	0	0	10
90-mm recoilless rifle								
Active	9	5	2	5	0	4	3	1
Passive	0	0	0	0	0	0	0	1

b. Analysis

Source of variation	Sum of squares	Degrees of freedom	Variance estimate
Team	158.2	4	39.5***
Movement	24.0	1	24.0
$T \times M$	52.4	4	13.1
Residual	188.3	30	6.3
Total	422.9	39	—

***Significance level $\epsilon = 0.001$.

TABLE D7

Two-Factor Analysis of Variance: Time Helicopter Was in View during Attack Phase of Killer-Team Mission

a. Classification

Killer team T	Ground target M							
	Stationary				Fluid			
	Total time helicopter in view during replication, sec							
	R_1	R_2	R_3	R_4	R_1	R_2	R_3	R_4
SS-11 ENTAC	421	251	374	154	108	119	127	175
Active	370	367	597	202	175	458	117	23
Passive	4	9	7	94	0	0	26	1810
90-mm recoilless rifle								
Active	364	135	151	308	9	81	93	55
Passive	4	3	5	6	0	0	0	28

b. Analysis

Source of variation	Sum of squares	Degrees of freedom	Variance estimate
Team	388242.4	4	97060.6
Movement	4644.0	1	4644.0
T × M	561510.3	4	140377.6
Residual	2715103.3	30	90503.4
Total	3669500.0	39	—

TABLE D8

Two-Factor Analysis of Variance: Time Helicopter Was under Fire during Attack Phase of Killer-Team Mission

a. Classification

Killer team T	Ground target M							
	Stationary				Fluid			
	Total time helicopter under fire during replication, sec							
	R_1	R_2	R_3	R_4	R_1	R_2	R_3	R_4
SS-11 ENTAC	125	70	80	27	20	13	58	82
Active	197	55	112	135	35	202	0	14
Passive	0	3	0	19	0	0	0	333
90-mm recoilless rifle								
Active	110	52	11	86	0	26	40	7
Passive	0	0	0	0	0	0	0	7

b. Analysis

Source of variation	Sum of squares	Degrees of freedom	Variance estimate
Team	35988.9	4	8997.2
Movement	1500.6	1	1500.6
T × M	24688.3	4	6172.1
Residual	134851.3	30	4495.0
Total	197029.1	39	—

TABLE D9

Two-Factor Analysis of Variance: Times Helicopter Was Sighted during Entry and Attack Phases of Killer-Team Mission

a. Classification

Killer Team T	Ground target M							
	Stationary				Fluid			
	Times helicopter sighted during replication							
	R_1	R_2	R_3	R_4	R_1	R_2	R_3	R_4
SS-11 ENTAC	18	25	25	12	10	5	15	7
Active	14	32	18	12	6	14	9	2
Passive	2	10	1	16	2	0	2	16
90-mm recoilless rifle								
Active	17	10	7	13	0	5	7	2
Passive	14	5	8	3	0	0	0	2

b. Analysis

Source of variation	Sum of squares	Degrees of freedom	Variance estimate
Team	686.6	4	171.7**
Movement	624.1	1	624.1***
$T \times M$	104.4	4	26.1
Residual	966.0	30	32.2
Total	2381.1	39	—

**Significance level $\epsilon = 0.01$.
***Significance level $\epsilon = 0.001$.

TABLE D10

Two-Factor Analysis of Variance: Times Helicopter Was Fired at during Entry and Attack Phases of Killer-Team Mission

a. Classification

Killer team I	Ground target M							
	Stationary				Fluid			
	Times helicopter fired at during replication							
	R_1	R_2	R_3	R_4	R_1	R_2	R_3	R_4
SS-11 ENTAC	10	10	14	6	4	3	7	6
Active	10	7	6	10	5	8	2	2
Passive	0	4	0	11	0	0	0	13
90-mm recoilless rifle								
Active	13	6	2	5	0	4	3	1
Passive	5	0	1	0	0	0	0	1

b. Analysis

Source of variation	Sum of squares	Degrees of freedom	Variance estimate
Team	210.1	4	52.5**
Movement	93.0	1	93.0*
$T \times M$	33.1	4	8.3
Residual	379.8	30	12.7
Total	716.0	39	—

*Significance level $\epsilon = 0.05$.
**Significance level $\epsilon = 0.01$.

TABLE D11

Two-Factor Analysis of Variance: Time Helicopter Was in View during Entry and Attack Phases of Killer-Team Mission

a. Classification

Killer team, T	Ground target M							
	Stationary				Fluid			
	Total time helicopter in view during replication, sec							
	R_1	R_2	R_3	R_4	R_1	R_2	R_3	R_4
SS-11 ENTAC	467	475	606	308	145	247	520	231
Active	382	533	769	368	175	647	193	23
Passive	52	198	7	357	26	0	26	1936
90-mm recoilless rifle								
Active	495	201	306	389	0	81	93	55
Passive	208	237	86	40	0	0	0	36

b. Analysis

Source of variation	Sum of squares	Degrees of freedom	Variance estimate
Team	558101.2	4	139525.3
Movement	105062.4	1	105062.4
$T \times M$	527551.3	4	131887.8
Residual	3361833.0	30	112061.1
Total	4552547.9	39	—

TABLE D12

Two-Factor Analysis of Variance: Time Helicopter Was under Fire during Entry and Attack Phases of Killer-Team Mission

a. Classification

Killer team T	Ground target M							
	Stationary				Fluid			
	Total time helicopter under fire during replication, sec							
	R_1	R_2	R_3	R_4	R_1	R_2	R_3	R_4
SS-11 ENTAC	128	113	111	61	28	19	148	82
Active	197	63	112	148	35	215	7	14
Passive	0	38	0	94	0	0	0	348
90-mm recoilless rifle								
Active	190	64	11	86	0	26	40	7
Passive	23	0	12	0	0	0	0	7

b. Analysis

Source of variation	Sum of squares	Degrees of freedom	Variance estimate
Team	41956.9	4	10489.2
Movement	5640.6	1	5640.6
$T \times M$	20012.0	4	5003.0
Residual	167165.3	30	5572.2
Total	234774.8	39	—

TABLE D13

Three-Factor Analysis of Variance: Times Helicopter Was Sighted during Entry Phase of Killer-Team Mission

a. Classification

Dismounted element weapon W	Helicopter participation P	Ground target M							
		Stationary				Fluid			
		Times helicopter sighted during replication							
		R_1	R_2	R_3	R_4	R_1	R_2	R_3	R_4
ENTAC	Active	1	10	3	2	0	6	3	0
ENTAC	Passive	1	9	0	15	2	0	0	5
90-mm recoilless rifle	Active	5	4	1	2	0	0	0	0
90-mm recoilless rifle	Pasaive	13	4	7	2	0	0	0	1

b. Analysis

Source of variation	Sum of squares	Degrees of freedom	Variance estimate
Weapon	10.1	1	10.1
Participation	15.1	1	15.1
Movement	120.1	1	120.1**
$W \times P$	2.0	1	2.0
$W \times M$	4.5	1	4.5
$P \times M$	13.0	1	18.0
$W \times P \times M$	0.1	1	0.1
Residual	322.0	24	13.4
Total	491.9	31	—

**Significance level $\epsilon = 0.01$.

TABLE D14

Three-Factor Analysis of Variance: Times Helicopter Was Fired at during Entry Phase of Killer-Team Mission

a. Classification

Dismounted element weapon W	Helicopter participation P	Ground target M							
		Stationary				Fluid			
		Times helicopter fired at during replication							
		R_1	R_2	R_3	R_4	R_1	R_2	R_3	R_4
ENTAC	Active	0	1	0	2	0	1	2	0
ENTAC	Passive	0	3	0	10	0	0	0	3
90-mm recoilless rifle	Active	4	1	0	0	0	0	0	0
90-mm recoilless rifle	Passive	5	0	1	0	0	0	0	0

b. Analysis

Source of variation	Sum of squares	Degrees of freedom	Variance estimate
Weapon	3.8	1	3.8
Participation	3.8	1	3.8
Movement	13.8	1	13.8
$W \times P$	2.5	1	2.5
$W \times M$	0.0	1	0.0
$P \times M$	3.8	1	3.8
$W \times P \times M$	2.5	1	2.5
Residual	106.8	24	4.4
Total	137.0	31	—

TABLE D15

Three-Factor Analysis of Variance: Time Helicopter Was in View during Entry Phase of Killer-Team Mission

a. Classification

Dismounted element weapon W	Helicopter partici-pation P	Ground target M							
		Stationary				Fluid			
		Total time helicopter in view during replication, sec							
		R_1	R_2	R_3	R_4	R_1	R_2	R_3	R_4
ENTAC	Active	12	166	172	166	0	189	76	0
ENTAC	Passive	48	189	0	263	26	0	0	126
90-mm recoilless rifle	Active	131	66	155	81	0	0	0	0
90-mm recoilless rifle	Passive	204	234	81	34	0	0	0	8

b. Analysis

Source of variation	Sum of squares	Degrees of freedom	Variance estimate
Weapon	6022.5	1	6022.5
Participation	0.0	1	0.0
Movement	77716.5	1	77716.5***
W × P	2064.0	1	2064.0
W × M	4488.8	1	4488.8
P × M	1365.0	1	1365.0
W × P × M	7.0	1	7.0
Residual	130602.3	24	5441.8
Total	222266.1	31	—

***Significance level $\epsilon = 0.001$.

TABLE D16

Three-Factor Analysis of Variance: Time Helicopter Was under Fire during Entry Phase of Killer-Team Mission

a. Classification

Dismounted element weapon W	Helicopter partici-pation P	Ground target M							
		Stationary				Fluid			
		Total time helicopter under fire during replication, sec							
		R_1	R_2	R_3	R_4	R_1	R_2	R_3	R_4
ENTAC	Active	0	8	0	13	0	13	7	0
ENTAC	Passive	0	35	0	75	0	0	0	15
90-mm recoilless rifle	Active	80	12	0	0	0	0	0	0
90-mm recoilless rifle	Passive	23	0	12	0	0	0	0	0

b. Analysis

Source of variation	Sum of squares	Degrees of freedom	Variance estimate
Weapon	47.5	1	47.5
Participation	22.8	1	22.8
Movement	1554.0	1	1554.0
W × P	621.3	1	621.3
W × M	30.0	1	30.0
P × M	42.8	1	42.8
W × P × M	712.5	1	712.5
Residual	9029.3	24	376.2
Total	12060.2	31	—

TABLE D17

Three-Factor Analysis of Variance: Times Helicopter Was Sighted during Attack Phase of Killer-Team Mission

a. Classification

Dismounted element weapon W	Helicopter participation P	Ground target M							
		Stationary				Fluid			
		Times helicopter sighted during replication							
		R_1	R_2	R_3	R_4	R_1	R_2	R_3	R_4
ENTAC	Active	13	22	15	10	6	8	6	2
ENTAC	Passive	1	1	1	1	0	0	2	11
90-mm recoilless rifle	Active	12	6	6	11	0	5	7	2
90-mm recoilless rifle	Passive	1	1	1	1	0	0	0	1

b. Analysis

Source of variation	Sum of squares	Degrees of freedom	Variance estimate
Weapon	63.3	1	63.3*
Participation	371.3	1	271.3***
Movement	87.8	1	87.8**
W × P	13.8	1	13.8
W × M	0.8	1	0.8
P × M	132.0	1	132.0**
W × P × M	26.3	1	26.3
Residual	240.3	24	10.0
Total	935.6	31	—

*Significance level $\epsilon = 0.05$.
**Significance level $\epsilon = 0.01$.
***Significance level $\epsilon = 0.001$.

TABLE D18

Three-Factor Analysis of Variance: Times Helicopter Was Fired at during Attack Phase of Killer-Team Mission

a. Classification

Dismounted element weapon W	Helicopter participation P	Ground target M							
		Stationary				Fluid			
		Times helicopter fired at during replication							
		R_1	R_2	R_3	R_4	R_1	R_2	R_3	R_4
ENTAC	Active	10	6	6	8	5	7	0	2
ENTAC	Passive	0	1	0	1	0	0	0	10
90-mm recoilless rifle	Active	9	5	2	5	0	4	3	1
90-mm recoilless rifle	Passive	0	0	0	0	0	0	0	1

b. Analysis

Source of variation	Sum of squares	Degrees of freedom	Variance estimate
Weapon	21.1	1	21.1
Participation	112.5	1	112.5**
Movement	12.5	1	12.5
W × P	0.5	1	0.5
W × M	0.5	1	0.5
P × M	45.1	1	45.1*
W × P × M	3.1	1	3.1
Residual	151.5	24	6.3
Total	346.8	31	—

*Significance level $\epsilon = 0.05$.
**Significance level $\epsilon = 0.01$.

TABLE D19

Three-Factor Analysis of Variance: Time Helicopter Was in View during Attack Phase of Killer-Team Mission

a. Classification

Dismounted element weapon W	Helicopter participation P	Ground target M							
		Stationary				Fluid			
		Total time helicopter in view during replication, sec							
		R_1	R_2	R_3	R_4	R_1	R_2	R_3	R_4
ENTAC	Active	370	367	597	202	175	458	117	23
ENTAC	Passive	4	9	7	94	0	0	26	1810
90-mm recoilless rifle	Active	364	135	151	308	0	81	93	55
90-mm recoilless rifle	Passive	4	3	5	6	0	0	0	28

b. Analysis

Source of variation	Sum of squares	Degrees of freedom	Variance estimate
Weapon	286146.1	1	286146.1
Participation	70312.5	1	70312.5
Movement	1800.0	1	1800.0
W × P	19110.1	1	19110.1
W × M	87990.1	1	87990.1
P × M	324818.0	1	324818.0
W × P × M	95266.1	1	95266.1
Residual	2668650.5	24	111193.8
Total	3554093.4	31	—

TABLE D20

Three-Factor Analysis of Variance: Time Helicopter Was under Fire during Attack Phase of Killer-Team Mission

a. Classification

Dismounted element weapon W	Helicopter participation P	Ground target M							
		Stationary				Fluid			
		Total time helicopter under fire during replication, sec							
		R_1	R_2	R_3	R_4	R_1	R_2	R_3	R_4
ENTAC	Active	197	55	112	135	35	202	0	14
ENTAC	Passive	0	3	0	19	0	0	0	333
90-mm recoilless rifle	Active	110	52	11	86	0	26	40	7
90-mm recoilless rifle	Passive	0	0	0	0	0	0	0	7

b. Analysis

Source of variation	Sum of squares	Degrees of freedom	Variance estimate
Weapon	18336.1	1	18336.1
Participation	16200.0	1	16200.0
Movement	420.5	1	420.5
W × P	153.1	1	153.1
W × M	1830.1	1	1830.1
P × M	17672.0	1	17672.0
W × P × M	4186.1	1	4186.1
Residual	126823.5	24	5284.3
Total	185621.4	31	5284.3

TABLE D21

Three-Factor Analysis of Variance: Times Helicopter Was Sighted during Entry and Attack Phases of Killer-Team Mission

a. Classification

Dismounted element weapon W	Helicopter participation P	Ground target M							
		Stationary				Fluid			
		Times helicopter sighted during replication							
		R_1	R_2	R_3	R_4	R_1	R_2	R_3	R_4
ENTAC	Active	14	32	38	12	6	14	9	2
ENTAC	Passive	2	10	1	16	2	0	2	16
90-mm recoilless rifle	Active	17	10	7	13	0	5	7	2
90-mm recoilless rifle	Passive	14	5	8	3	0	0	0	2

b. Analysis

Source of variation	Sum of squares	Degrees of freedom	Variance estimate
Weapon	124.0	1	124.0
Participation	236.5	1	236.5*
Movement	413.3	1	413.3**
W × P	26.3	1	26.3
W × M	1.5	1	1.5
P × M	52.5	1	52.5
W × P × M	30.0	1	30.0
Residual	791.3	24	33.0
Total	1675.4	31	—

*Significance level $\epsilon = 0.05$.
**Significance level $\epsilon = 0.01$.

TABLE D22

Three-Factor Analysis of Variance: Times Helicopter Was Fired at during Entry and Attack Phases of Killer-Team Mission

a. Classification

Dismounted element weapon W	Helicopter participation P	Ground target M							
		Stationary				Fluid			
		Times helicopter fired at during replication							
		R_1	R_2	R_3	R_4	R_1	R_2	R_3	R_4
ENTAC	Active	10	7	5	10	5	8	2	2
ENTAC	Passive	0	4	0	12	0	0	0	13
90-mm recoilless rifle	Active	13	6	2	5	0	4	3	1
90-mm recoilless rifle	Passive	5	0	1	0	0	0	0	1

b. Analysis

Source of variation	Sum of squares	Degrees of freedom	Variance estimate
Weapon	42.8	1	42.8
Participation	75.0	1	75.0*
Movement	52.5	1	52.5
W × P	0.8	1	0.8
W × M	0.8	1	0.8
P × M	22.8	1	22.8
W × P × M	0.0	1	0.0
Residual	337.8	24	14.1
Total	532.5	31	—

*Significance level $\epsilon = 0.05$.

TABLE D23

Three-Factor Analysis of Variance: Time Helicopter Was under Fire during Entry and Attack Phases of Killer-Team Mission

a. Classification

Dismounted element weapon W	Helicopter participation P	Ground target M							
		Stationary				Fluid			
		Total time helicopter under fire during replication, sec							
		R_1	R_2	R_3	R_4	R_1	R_2	R_3	R_4
ENTAC	Active	197	63	112	148	35	215	7	14
ENTAC	Passive	0	38	0	94	0	0	0	348
90-mm recoilless rifle	Active	190	64	11	86	0	26	40	7
90-mm recoilless rifle	Passive	23	0	12	0	0	0	0	7

b. Analysis

Source of variation	Sum of squares	Degrees of freedom	Variance estimate
Weapon	20250.8	1	20250.8
Participation	15007.8	1	15007.8
Movement	3591.3	1	3591.3
W × P	157.5	1	157.5
W × M	2329.0	1	2329.0
P × M	15975.8	1	15975.0
W × P × M	1444.5	1	1444.5
Residual	154021.8	24	6417.6
Total	212778.5	31	—

TABLE D24

Three-Factor Analysis of Variance: Time Helicopter Was in View during Entry and Attack Phases of Killer-Team Mission

a. Classification

Dismounted element weapon W	Helicopter participation P	Ground target M							
		Stationary				Fluid			
		Total time helicopter in view during replication, sec							
		R_1	R_2	R_3	R_4	R_1	R_2	R_3	R_4
ENTAC	Active	382	533	769	368	175	647	193	23
ENTAC	Passive	52	198	7	357	26	0	26	1936
90-mm recoilless rifle	Active	495	201	306	389	0	81	93	55
90-mm recoilless rifle	Passive	208	257	86	40	0	0	0	36

b. Analysis

Source of variation	Sum of squares	Degrees of freedom	Variance estimate
Weapon	375194.5	1	375194.5
Participation	70406.3	1	70406.3
Movement	55861.5	1	55861.5
W × P	8613.3	1	8613.3
W × M	132226.5	1	132226.5
P × M	284069.5	1	284069.5
W × P × M	96910.0	1	96910.0
Residual	3238020.3	24	134917.5
Total	4251301.9	31	—

TABLE D25

Three-Factor Analysis of Variance: Times Dismounted Killer Elements Were Sighted during Attack Phase of Mission

a. Classification

Dismounted element weapon W	Helicopter participation P	Ground target M							
		Stationary				Fluid			
		Times DKEs sighted during replication							
		R_1	R_2	R_3	R_4	R_1	R_2	R_3	R_4
ENTAC	Active	1	0	3	1	1	2	1	1
ENTAC	Passive	1	1	0	0	0	3	0	2
90-mm recoilless rifle	Active	3	2	2	0	3	0	5	3
90-mm recoilless rifle	Passive	1	3	1	5	3	3	2	1

b. Analysis

Source of variation	Sum of squares	Degrees of freedom	Variance estimate
Weapon	12.5	1	12.5*
Participation	0.1	1	0.1
Movement	1.1	1	1.1
W × P	0.5	1	0.5
W × M	0.0	1	0.0
P × M	0.1	1	0.1
W × P × M	2.0	1	2.0
Residual	44.5	24	1.9
Total	60.8	31	—

*Significance level $\epsilon = 0.05$.

TABLE D26

Three-Factor Analysis of Variance: Times Dismounted Killer Elements Were Fired at during Attack Phase of Mission

a. Classification

Dismounted element weapon W	Helicopter participation P	Ground target M							
		Stationary				Fluid			
		Times DKEs fired at during replication							
		R_1	R_2	R_3	R_4	R_1	R_2	R_3	R_4
ENTAC	Active	1	0	1	1	0	2	0	1
ENTAC	Passive	1	1	0	0	0	1	0	2
90-mm recoilless rifle	Active	1	1	2	0	3	0	3	3
90-mm recoilless rifle	Passive	0	1	1	1	3	2	2	0

b. Analysis

Source of variation	Sum of squares	Degrees of freedom	Variance estimate
Weapon	4.5	1	4.5*
Participation	0.5	1	0.5
Movement	3.1	1	3.1
W × P	0.1	1	0.1
W × M	2.0	1	2.0
P × M	0.0	1	0.0
W × P × M	0.1	1	0.1
Residual	21.5	24	0.9
Total	31.8	31	—

*Significance level $\epsilon = 0.05$.

TABLE D27

Three-Factor Analysis of Variance: Time Dismounted Killer Elements Were in View during Attack Phase of Mission

a. Classification

Dismounted element weapon W	Helicopter participation P	Ground target M							
		Stationary				Fluid			
		Total time DKEs in view during replication, sec							
		R_1	R_2	R_3	R_4	R_1	R_2	R_3	R_4
ENTAC	Active	45	0	102	30	10	55	10	3
ENTAC	Passive	182	21	0	0	0	30	0	72
90-mm recoilless rifle	Active	29	21	61	0	74	6	169	101
90-mm recoilless rifle	Passive	6	24	7	31	52	95	86	11

b. Analysis

Source of variation	Sum of squares	Degrees of freedom	Variance estimate
Weapon	1212.8	1	1212.8
Participation	331.5	1	331.5
Movement	1498.8	1	1498.8
W × P	1046.5	1	1046.5
W × M	11212.5	1	11212.5*
P × M	148.8	1	148.8
W × P × M	63.3	1	63.3
Residual	55105.3	24	2296.1
Total	70619.5	31	—

*Significance level $\epsilon = 0.05$.

TABLE D28

Three-Factor Analysis of Variance: Time Dismounted Killer Elements Were under Fire during Attack Phase of Mission

a. Classification

Dismounted element weapon W	Helicopter participation P	Ground target M							
		Stationary				Fluid			
		Total time DKEs under fire during replication, sec							
		R_1	R_2	R_3	R_4	R_1	R_2	R_3	R_4
ENTAC	Active	16	0	4	20	6	31	0	6
ENTAC	Passive	2	10	0	0	0	6	0	20
90-mm recoilless rifle	Active	7	2	30	0	18	0	29	14
90-mm recoilless rifle	Passive	0	1	6	5	24	24	23	0

b. Analysis

Source of variation	Sum of squares	Degrees of freedom	Variance estimate
Weapon	157.5	1	157.5
Participation	87.8	1	87.8
Movement	282.0	1	282.0
W × P	5.3	1	5.3
W × M	116.3	1	116.3
P × M	63.3	1	63.3
W × P × M	16.5	1	16.5
Residual	2635.3	24	109.8
Total	3365.0	31	—

of the evasiveness of the DKEs are provided in Tables D25 to D28. These analyses indicated that:

(a) Significantly more acquisitions and firings were recorded against recoilless-rifle crews than against ENTAC crews. Because there were two recoilless-rifle crews per mission compared with one ENTAC crew and because the recoilless-rifle crews had to come within 400 m of their targets, these findings are not unexpected.

(b) ENTAC crews were exposed for a significantly longer time to stationary vehicles than to fluid vehicles (380 vs 180 sec), but recoilless-rifle crews were exposed for significantly less time to stationary enemy elements than to fluid vehicles (179 vs 588 sec). This killer-team target-movement interaction can be attributed in part to the fact that against fluid vehicles the recoilless-rifle crews frequently selected ambush points in relatively open terrain offering limited cover during killer-element withdrawal, but against stationary targets the recoilless-rifle crews approached and withdrew from target-complex vehicles through wooded terrain whenever possible.

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